GRAND PRIX

SPEEDWAY™

USER GUIDE

Speedway Reader IPJ-R1000 for Gen 2 UHF RFID

- EPCglobal™ certified for dense-reader operation

- High-performance software radio architecture for maximum flexibility

- Monostatic antennas for low-cost deployment

- Patented interference rejection combined with high sensitivity ensures highest possible read reliability

Impinj®

USER GUIDE

Overview

The EPCglobal™-certified Speedway™ IPJ-R1000 reader is a fixed Gen 2 UHF RFID tag reader that provides network connectivity between tag data and enterprise system software.

A key element of Impinj's GrandPrix™ RFID system solution, the Speedway reader is the first high-performance reader designed from the ground up to support the EPCglobal Gen 2 standard in its entirety. That includes the accommodation of 640 kbps tag-to-reader data rates, robust performance in dense-reader environments (without the requirement for network synchronization), the elimination of ghost reads, and more. Combined with an extensible architecture that supports seamless integration of field-upgradeable, third party application software, the Speedway reader is the most adaptable reader solution available today.

This user guide provides instructions on how to install, connect, configure, operate, upgrade, and troubleshoot Speedway readers. It assumes the user is familiar with appropriate networking facilities, the EPCglobal Gen 2 specification, and general principles of RFID system management. **The user guide only covers readers having part numbers in the following format: IPJ-R1000-USA-N-NN-NN-NNN**.

Federal Communications Commission (FCC) Compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Consult the dealer or a qualified radio/TV technician for assistance

Note: Changes to this product will void the user's authority to operate per FCC Part 15.

Industry Canada (IC) Compliance

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This device has been designed to operate with the antenna(s) listed in section 1.4 and having a maximum gain of 6 dB. Antennas not included in this list or having a gain greater than 6 dB are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

Note: The term "IC:" before the radio certification number only signifies that Industry of Canada technical specifications were met.

Before You Begin

Please read this document in its entirety before operating the Speedway reader, as serious personal injury and/or equipment damage may result from improper use.

Table of Contents

1. Setting Up the Speedway Reader

Your Speedway reader has been shipped with the following:

- Speedway reader unit
- Power supply module (CUI, Inc., P/N **DTS240250UC-P11P-DB**) with 24VDC output (power supply module ordered separately). Note: the use of any other power supply module may cause damage to the reader.
- Several Impinj Monza™ Gen 2 tags to aid Speedway setup and system verification

1.1. Other System and Equipment Requirements

Table 1-1summarizes the supported operating environments.

Table 1-1   Operating Environments

Interface	Protocol	Recommended Tools		
		Windows	**Linux**	**Mac/Other**
Web Interface	HTTP	Any browser that supports Java		
Remote Login	SSH/Telnet	Putty	SSH or Telnet	Terminal
Serial	RS-232	Hyperterminal	Minicom	N/A

The components and accessories detailed below are required in order to ensure compliance with the Speedway reader. It is the responsibility of the user or professional installer to provide and properly use all these components and accessories:

- A PC running Windows 2000 (or higher), XP, or Linux PC, and
  - An available RS-232 serial port (required only if system does not support DHCP)
  - An Ethernet port
- http browser that includes Java Runtime Environment (JRE) of version 1.4.2 or later. Note that Windows 2000 default is version 1.3.1. The latest version of JRE can be downloaded from: **http://www.java.com/en/download/manual.jsp** (to determine/verify your version, go to http://www.java.com/en/download/installed.jsp).
- Standard, grounded DB9 serial cable (required only if system does not support IP provisioning)
- An Ethernet port
- Standard Ethernet cable(s)
- TCP/IP network equipment, as required to connect the reader to a PC, Mac, or other
- Impinj-approved UHF RFID antenna(s), including associated RF cable with RP-TNC male connector interface

1.2. Speedway Reader I/O Ports & Status

Refer to Figure 1-2 for the Speedway reader's major ports, connectors, and status indicators, which are clearly indicated on the unit. The Speedway reader is equipped with the following ports:

• RJ-45 Ethernet jack (labeled 10/100 BASE-T)
• Four female RP-TNC RF antenna connectors (ANT1 – ANT4)
• Female DB-9 connector for serial communication (SERIAL)
• Female DB-25 connector with user I/O capability (GPIO: RS-232 serial, four 3.3/5V logic inputs, eight 3.3V logic outputs)
See Table 1-2 for the pin-out. **Note: pins listed in Table 1-2 as "No connect" must be left unconnected.**

Table 1-2 DB-25 Connector Pin-Out

Pin	I/O	Pin	I/O	Pin	I/O
1	No connect	10	GPIN3	19	GPOUT5
2	RS-232 RXD	11	GPIN2	20	No connect
3	RS-232 TXD	12	GPIN1	21	GPOUT6
4	RS-232 CTS	13	GPIN0	22	No connect
5	RS-232 RTS	14	GPOUT0	23	GPOUT7
6	No connect	15	GPOUT1	24	No connect
7	Signal Ground	16	GPOUT2	25	No connect
8	No connect	17	GPOUT3		
9	No connect	18	GPOUT4		
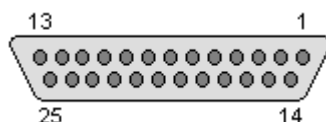
Figure 1-1 DB-25 Female Connector

The LEDs indicate *Power*, *Status*, and antenna activity. Note: the LEDs that correspond to the connected antenna(s), marked *1*,*2*,*3*, and *4*, only light green when active (transmitting). A description of the *Status* LED states appears in Table 1-3.

Table 1-3   LED Status Indicators

Reader Operation	LED Action
Startup	Continuous Red
Power-on Start Test (POST) Failure	Flashing Red (~2 Hz)
Bootloader Running	Off
File System Mounting Operation (May also occur in certain upgrade scenarios to indicate the unit is functional but in a file system operation that will take some time to complete.)	Alternately Flashing Red/Green (1 Hz)
Speedway Reader able to Accept Mach1™ Connection	Continuous Green
Speedway Reader in Active Mach1™ Connection	Flashing Green (1 Hz)
Inventory in Progress with Tags in Field	Flashing Orange (1 Hz)
Inventory in Progress with no Tags in Field (for 3 sec)	Flashing Orange (1/3 Hz)

Note: Mach1™ denotes the Speedway RFID Command Interface, used by the reader to communicate with EPCglobal™ Generation 2 (Gen 2) RFID tags.

| Mounting
Holes | RJ-45
Ethernet Jack | DB-9 Serial
Port | DB-25
GPIO Port | Power Supply
Input | RP-TNC RF Antenna
Connectors | Status
LEDs | Mounting
Holes |
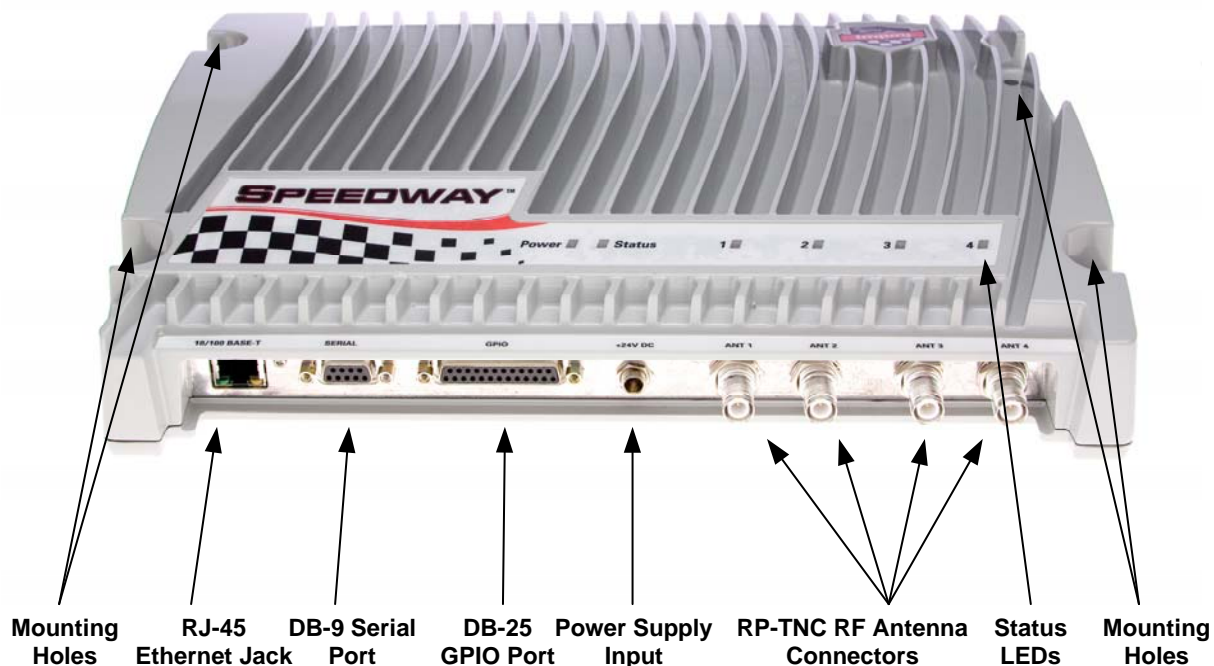
Figure 1-2   Impinj Speedway Reader Port Connections

1.3.   Mounting the Speedway Reader

When securing the unit with #10 screws via the four mounting holes, the Speedway reader may be mounted horizontally or vertically on a stable surface where it will be safe from disturbance. Keep the unit away from direct sunlight, high humidity, extreme temperatures, vibration, and sources of electromagnetic interference, as any combination of these conditions may degrade performance or shorten the life of the unit.

1.4.   Connecting Power

Connect the AC power plug into a suitable 100-240 VAC, 50-60 Hz power outlet. The green *Power* LED will light when power is on. The reader will then begin its boot sequence (note: normal boot time for the reader's operating system is ~50 seconds). The reader cannot be commanded until the boot sequence is complete.

1.5.   Connecting the Antenna(s)

The Speedway reader is equipped with four (4) independent, bidirectional, full duplex TX/RX ports (monostatic), which must be cabled to their respective Impinj-approved antennas prior to power-up. **Unused antenna ports must be left unconnected; they should not be terminated.**

Note: Reader power has been factory preset to 30 dBm to accommodate an antenna with up to 6 dBi composite gain (inclusive of cabling). The Speedway reader may only be operated with Impinj-approved antennas and can radiate no more than 36 dBm EIRP per FCC Part 15.247 regulations. To obtain the maximum allowable reader power setting, the following expression should be used:

Maximum power setting (in dBm) = 36 – Antenna Gain (in dBi)

where the antenna gain includes the loss of the associated cable from the reader to the antenna.

Approved antenna vendors, model numbers, gain characteristics, and associated RF cable/connector include:

- Cushcraft Model Number S9028PCL/R (left- or right-hand CP); 6 dBi gain, with integrated pigtail to RP-TNC female connector
- Sensormatic Electronics Corp. model number IDANT20TNA25 with 25 foot Belden 7806A RG-58 coaxial cable (0.1 dB per foot loss); 5.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 25 foot Belden 7806A coaxial cable (0.1 dB per foot loss); 3.5 dBi composite gain
- Sensormatic Electronics Corp. model number IDANT10CNA25 with 6 foot Belden 7806A coaxial cable (0.1 dB per foot loss); 5.4 dBi composite gain

Please note: the use of any other antenna may cause damage to the reader and adversely affect performance.

2. Communicating with the Speedway Reader

Reader connectivity and control is accomplished via either network (Ethernet, TCP/IP) or serial (RS-232) interfaces on the Speedway unit (see Figure 2-1).

If connecting via Ethernet, see Section 2.2. Note that if your network equipment is not compatible with the default network configuration of the reader (DHCP), connecting via the serial interface will be necessary to establish initial command line-level communications with the Speedway reader. If making a direct serial connection, see Section 2.1.
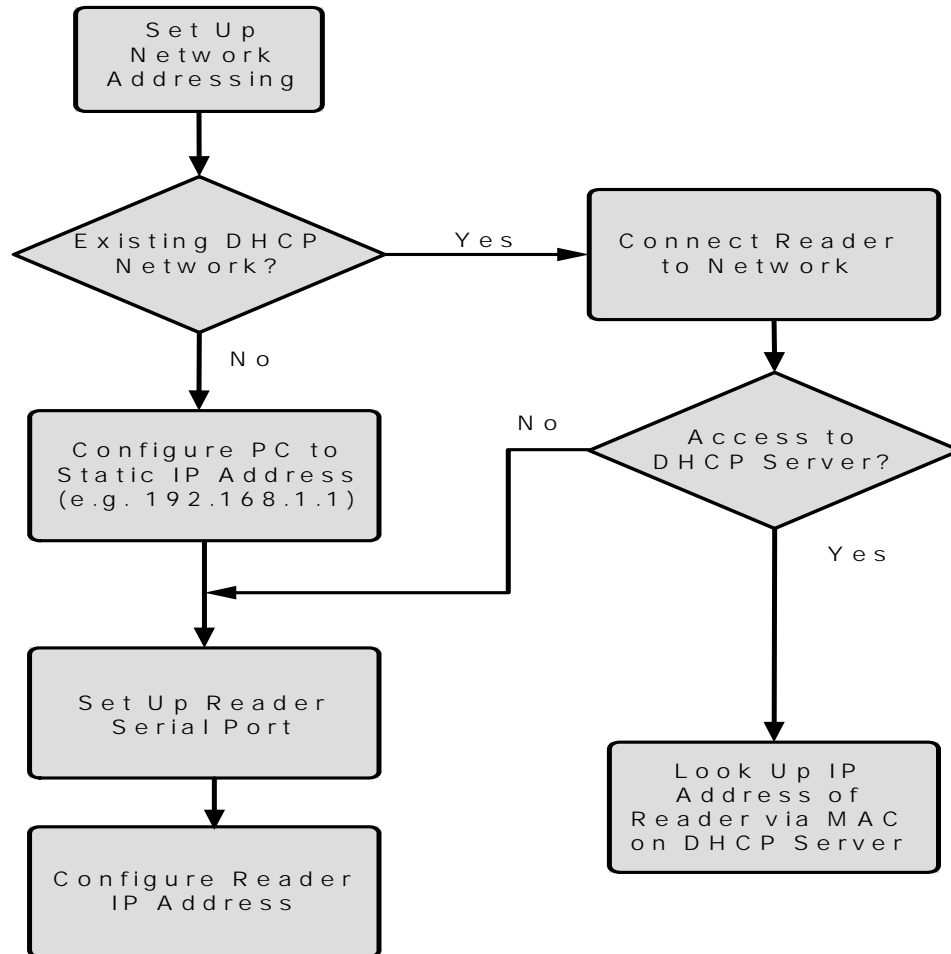
Figure 2-1 Configuration Options

2.1. Preparing Serial Connectivity

Serial communication with the reader can be used at any time in conjunction with, or in lieu of, Ethernet connectivity in order to configure the reader. The serial interface may be necessary to establish initial communications with the Speedway reader (via the command line interface) if your network equipment is not compatible with the default network configuration of the reader. In this case, the reader's network connection can be configured using the serial port; Ethernet connectivity can then be used for control thereafter, if desired.

Launch HyperTerminal (supplied with Microsoft Windows), or a similar communication program, such as Tera Term (also for Windows), or Minicom for Linux to establish serial reader communication. Configuration settings are entered via the command line interface (see section 3), accessed via your preferred terminal emulator, the prompt for which appears when the reader is connected to the PC via the serial port and booted.

With the connection established between the Speedway reader's serial port and the host PC's valid/active COM port, plug the reader's AC power unit into a suitable 100-240 VAC, 50-60 Hz power outlet. The *Power* LED will illuminate when power is applied. The reader will then begin its boot sequence. (Note: normal boot time for the reader's operating system is ~50 seconds. The reader cannot be commanded until the boot sequence is complete.)

Set the communication parameters of the terminal software per Figure 2-2 (Tera Term screenshot shown).
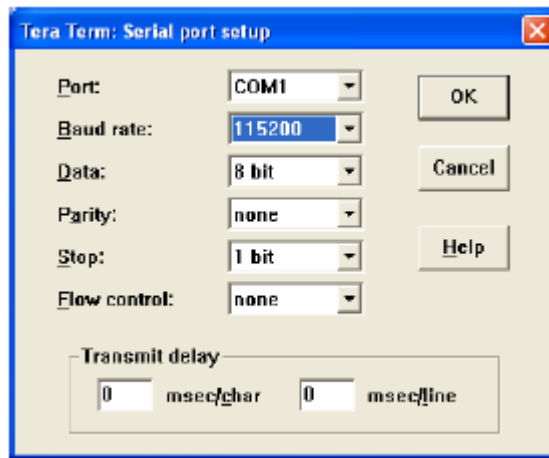
Figure 2-2 Serial Port Configuration

You're now ready to log onto the reader. The default login (case-sensitive) is as follows:

> User Name: root
> Password: impinj

The Speedway reader is now ready to accept command line instructions (see section 3).

2.2. **Preparing Ethernet (TCP/IP) Connectivity**

Connect the reader to your network via the Ethernet port (see Figure 2-3). If your network is capable of communicating to the reader in its default IP configuration (DHCP), then complete and verify connectivity as described below. Note that the host computer must be on the same subnet as the reader.

Ethernet

Ethernet

PC
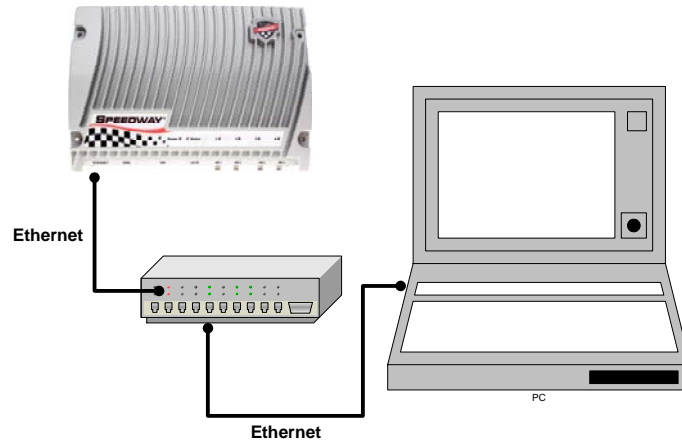
Figure 2-3 Ethernet Connectivity

Connect the computer's Ethernet port to the Speedway reader using one of the following two methods:

- Use of an Ethernet router or switch with either PC IP address set to a static address within the subnet of the reader (switch) or router's DHCP set to provide the PC with an IP address within the reader's subnet.
- Use of a single Ethernet crossover cable to connect directly to your PC with the PC IP address set to a static value (e.g., 192.168.1.10) within the subnet of the reader.

To verify correct TCP/IP connectivity ping (using the "ping" command) or traceroute (using the "traceroute" command in a Linux environment, or the "tracert" command in a Windows environment) the reader's IP address using the PC's command line interface. Once connectivity is established, open the computer's web browser application and connect to the Speedway reader's hosted webpage (see Section 3), and login to complete the Speedway reader configuration. The default login (case-sensitive) is as follows:

> User Name: root
> Password: impinj

You're now ready to configure the network. Proceed to section 3.

3. Network Configuration

The network may be configured for the Speedway reader using the Rshell command line interface (CLI), accessed via serial connectivity (see section 2.1). By default, the reader will provide a system name of **speedway-nn$_h$-nn$_h$-nn$_h$** to the DHCP server. The **nn$_h$-nn$_h$-nn$_h$** represents the host name suffix (simply concatenate the last three bytes of the unit's MAC address (as printed on the Speedway reader enclosure, and expressed in hexadecimal) to the word "speedway" separated by "-" to complete the host name entry, e.g., **speedway-00-00-0C**). Shown here are the essential configuration commands; for complete information on this interface, see section 6).

To view the reader's current configuration settings, at the prompt, enter the following command:

```
> show network summary
```

The reader will respond with the following (sample only; actual data will differ):

```
> show network summary
Status=0,'success'
ipAddressMode=dynamic
ipAddress=192.168.20.121
ipMask=255.255.255.0
gatewayAddress=192.168.20.1
broadcastAddress=192.168.20.255
hostname=speedway-00-00-0C
>
```

At this point, the TCP/IP configuration parameters, such as its IP status (static or dynamic) and hostname, may be changed via the following command examples:

• To set **hostname**, at the prompt, enter the command:

```
config network hostname <HOSTNAME>
```

• To set **static IP address**, at the prompt, enter the command:

```
config network ip static <IP ADDRESS> <NETMASK> <GATEWAY> <BROADCAST>
```

• Alternatively, either of the following two versions of the **config network ip static** command may be used, in which case the reader will use default values for the unspecified parameters:

```
config network ip static <IP ADDRESS>
config network ip static <IP ADDRESS> <GATEWAY>
```

• To set **DHCP**, at the prompt, enter the command:

```
config network ip dynamic
```

You may now continue to use the Speedway reader in serial mode or connect to the network via the Speedway reader's Ethernet port.

4. Speedway Reader Settings

If you haven't already done so, navigate to the Speedway reader's hosted webpage. If using DHCP with DNS hostname registration enabled, connect via the default host name by navigating the browser to http://**speedway-nn$_h$-nn$_h$-nn$_h$**, where **nn$_h$-nn$_h$-nn$_h$** represents the host name suffix (simply concatenate the last three bytes of the unit's MAC address (as printed on the Speedway reader enclosure, and expressed in hexadecimal) to the word "speedway" separated by "-" to complete the host name entry (e.g., **speedway-00-00-0C**). If your DHCP server does not support DNS hostname registration, the option has been turned off in Rshell or you are using a static IP address navigate to the IP address assigned or the host name manually specified in your DNS server. You'll then be directed to the specific Speedway unit's homepage (see Figure 4-1), which details the hostname, IP address, serial number, hardware revision, and system statistics information. Note that the actual GUI appearance may vary from that shown in this User's Guide.

Figure 4-1 Speedway Reader Homepage

The Speedway reader applet is a Java program that runs from within a web browser (see Figure 4-1). Speedway requires Java Runtime Environment (JRE), version 1.4.2 or later. Note that Windows 2000 default is 1.3.1. The latest version of JRE can be downloaded from: **http://java.com/en/download/manual.jsp**

The Speedway reader applet is accessed via the RFID menu tab at the top of this page. (If the applet is opened, no other external software may connect to the reader via Mach1™.) Clicking this tab will bring up a dialog box prompting the user to enter a login ID and password, the default for which is:

> User name: root
> Password: impinj

The Java applet will load and open the **Settings** page (see Figure 4-2).

The five user-selected fields on the **Settings** page include **Mode**, **Antenna**, **Session**, **Transmit Power**, and **Channel**, each of which are described below.
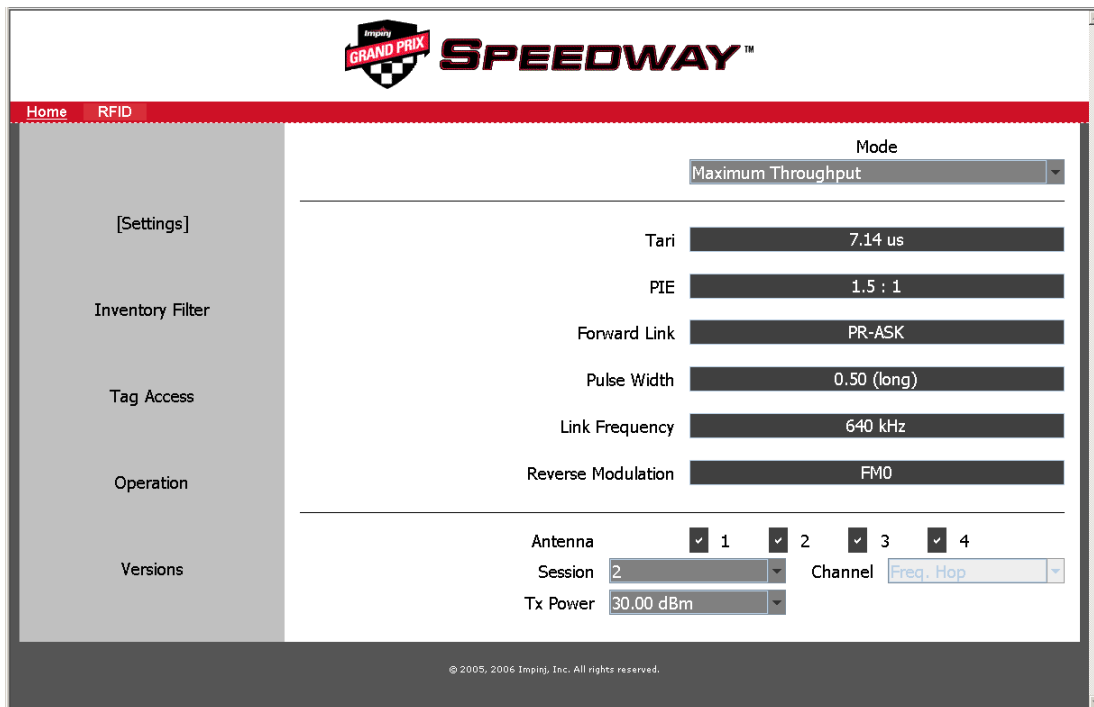
Figure 4-2 Speedway Reader Settings Page

Mode
The reader mode is established via the Mode pull-down menu. Mode profile is a factory preset that configures the reader according to the mode's respective default settings.

Antenna
The Speedway reader supports four (4) independent, bidirectional, full duplex TX/RX ports, which must be cabled to their respective, Impinj-approved antennas prior to power-up. Each antenna port is labeled (ANT1−ANT4) on the Speedway unit, and these designations correspond to the **Antenna** selection buttons that appear on the lower third of the screen. Only those antennas activated by clicking the appropriate button(s) will be operational.

Session
The reader may be assigned to one of three **Session**s (1−3), selectable via this pull-down menu. A function of dense-reader mode, the use of sessions allows as many as three different readers to access the same population of tags through a time-interleaved process. In this mode, a shelf-mounted reader in the midst of a counting operation (assigned to, say, session 1), for example, may be interrupted by another reader entering the field—possibly a handheld reader—to perform its own inventory operation (in session 2, perhaps). A dock door or forklift reader, assigned to session 3, might also initiate an inventory round. Because Gen 2 tags maintain a separate "inventoried" flag to keep track of each of these various random and independent sessions, they're able to seamlessly resume their participation.

Transmit Power
The reader power setting is selected from the **Tx Power** pull-down menu. The output power ranges from 15 dBm to a maximum of 30 dBm (in .25 dB increments), measured at the Speedway reader's antenna ports.

Channel
The FCC stipulates frequency hopping across the North American spectrum allocated to UHF RFID (902−928 MHz, with hopping occurring between 902.75−927.25 MHz in 500 KHz steps). As such, the Speedway reader does not allow the setting of a static frequency. For North American operation, **Channel** is factory-set and fixed to frequency hop.

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5. Using the Speedway Reader

Once the Speedway reader settings have been established, you can proceed directly to the **Operation** screen by clicking its menu navigation button. From the **Operation** page, simply click the **Start** button to begin reading tags that might be in the field. For more sophisticated inventory operations, the **Inventory Filter** and **Tag Access** pages allow the selection of tags according to user-specified criteria and rules. To access the Inventory Filter, Tag Access or protocol setup menus any currently executing Operation must be stopped.

5.1. Operation

If the **Halt Filter** has been activated in **Tag Access**, this status will be indicated in the **Operation** screen view (see Figure 5-1) with the text **Halt Filter** appearing at the top of the screen. Likewise, if the **Inventory Filter** has been activated, the text **Inventory Filter** will also appear. The inventory operation is enabled via the **Start/Stop** toggle button.

Auto Continue
Referring to the set of three buttons in the lower-left portion of the screen, **Auto Continue** directs the reader to continue singulation after a halt condition has been met. Otherwise, if the **Halt Filter** has been set, the reader will stop reading and return control to the user, resuming operation only when the **Continue** button has been clicked by the user. Note also that **Halt** does not require any subsequent action.

Act Once
The **Act Once** button, if enabled, directs the reader to execute the action indicated in the **Tag Access Action** setting (read, write, lock, kill, etc.) only one time. If the operation is successful (see **Last Status** column in the primary read window), the reader will continue inventorying or halt operation, depending on the status of the **Auto Continue** setting. Note that if the **Act Once** setting is *not* enabled, and the action indicated is a write, the reader will continuously write the tag over and over in a continuous loop. If, on the other hand, both **Act Once** and **Auto Continue** are enabled, the reader will write the tag once, and then continue the inventory operation, responding in accordance with the **Inventory Filter** settings that have been established.

Read TID
As tags are read, their EPC numbers appear in the primary window of the **Operation** screen. If the **Read TID** button has also been enabled, the logo of the tag silicon manufacturer corresponding to the TID will also be displayed.

Monitoring Inventory Results
The **Start/Stop** button controls singulation of tags within range of the reader. In addition to the EPC and TID (if enabled), the results displayed include **Read Rate** (expressed as tags/sec) and **Running Time** (in hh:mm:ss from last Start). **Total Tags** and **Total Active Tags** report statistics on the total number of tags read as well as the number of tags currently in the reader's field of view. Active tags being read are displayed in white fields, and fade to blue after not being seen by the reader within the last ~10 seconds. To see all tags and their status, simply scroll the screen. Finally, the **Clear** button clears the results of the inventory operation that commenced with **Start**.

To change settings from **Operation** mode:

a. Stop continuous singulation using the **Start/Stop** button
b. Return to **Home** screen and configure reader to desired new mode
c. Return to **Operation** mode and re-start continuous singulation
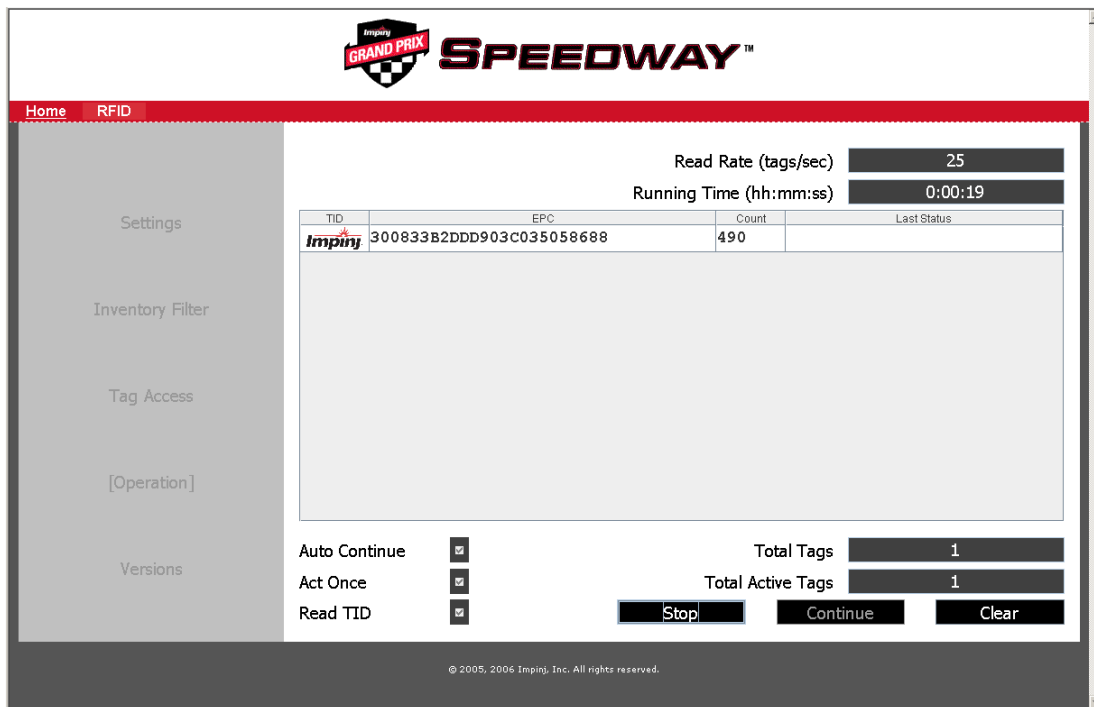
Figure 5-1 Operation

5.2. Tag Filters

The **Inventory Filter** screen (see Figure 5-2) is the user interface to the *Select* command, which the reader may apply successively to sort a particular tag population based on user-defined criteria, which may include union, intersection, and negation-based tag partitioning (union and intersection operations are performed by issuing successive *Select* commands).

Select commands apply to a single memory bank; the **MemBank** field specifies if the criteria applies to the TID, EPC, or user memory, as follows:

> MemBank 00 (0): Reserved
> MemBank 01 (1): EPC
> MemBank 10 (2): TID
> MemBank 11 (3): User

Successive *Selects* may apply to different memory banks. The **Bit Offset** and **Bit Length** fields are used to target a specific portion of the tag memory on which to perform the filtering, while the **Pattern** field contains the comparison bits of interest. As tags are read, the pattern is evaluated against the *Select* criteria, which includes *Equal* and *Not Equal* options in the **Comparison** field.

The **Inventory Filter** allows the use of two sets of criteria (defined by primary filter **A** and secondary filter **B**) that may be used separately, jointly, or not at all (the pull-down options include No Filter, A ONLY, A AND B, A OR B). When applied to an inventory round, only those tags that match the S*elect* criteria will be displayed.
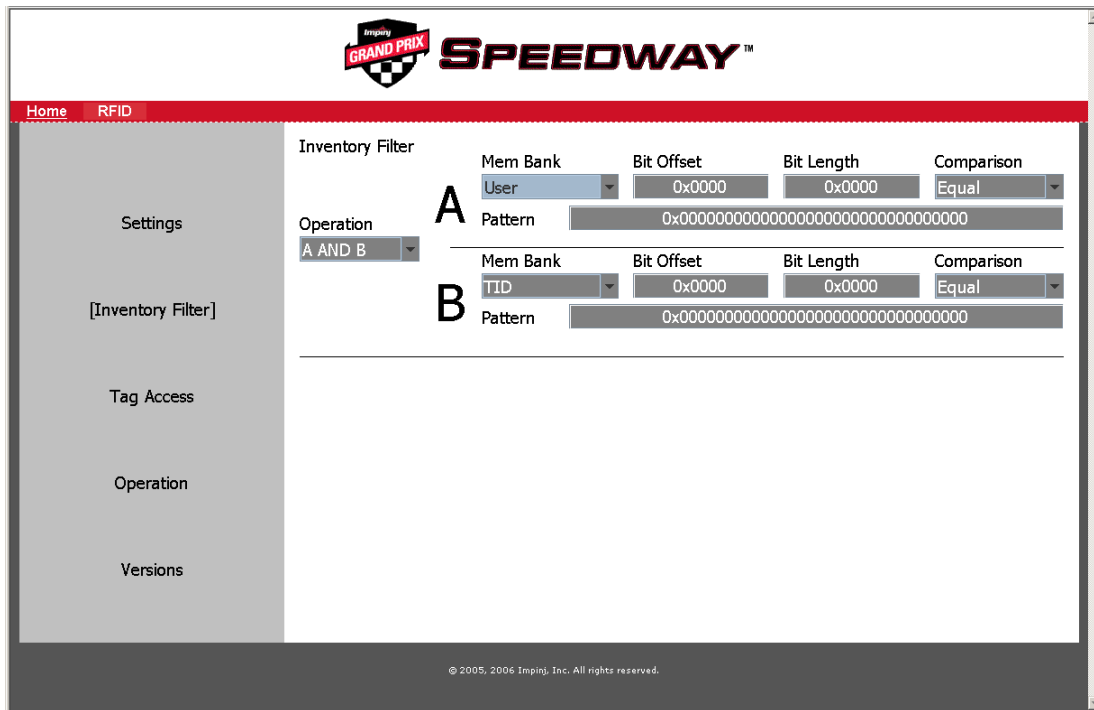
Figure 5-2 Inventory Filter

5.3. Accessing Tags

After acknowledging a tag, the Speedway reader may choose to access it. Under the **Tag Access** menu, a pull down menu provides four command **Actions**: *Read, Write, BlockWrite, Lock, and Kill.*

The menu item **Tag Access** (see Figure 5-3) adds a **Mask** field to the filtering operation, which allows the user to mask individual "don't care" bits or segments of the matching pattern, where "1" identifies a bit of interest and "0" represents a masked bit.

Tag Access differs from the **Inventory Filter** operations in several respects. First, rather than simply continuously inventorying a population of tags, **Tag Access** allows the user to automatically **Halt** the inventory process upon finding a tag of interest (e.g., a tag that meets the **Halt Filter** criteria). At this point, the tag can be automatically read, written, locked, or killed, according to the action selected in the **Action** pull-down menu. Furthermore, the action is applied only to the selected **MemBank**, and within it, the desired memory rows (00–07), the rows being made up of 16-bit words. If **Action** calls for a write, the specific bit pattern to be written must be entered (in hex format) in the corresponding field(s) below the selected row number(s). Note that multiple selected rows must be contiguous.

The **Tag Access** view is consistent with the **Operation** view (described in section 5.1) in that settings applied to one are valid for the other.

Figure 5-3 Tag Access

5.4. Versions

The **Version** screen (see Figure 5-4) simply reports the versions of the four primary components of the Speedway reader.

Figure 5-4 Version

6. Firmware Upgrade

The Speedway reader provides methods for managing the firmware image which include:

- Upgrade to a new image
- Fallback to a previous valid image
- Restoration of factory defaults

These can be done without disturbing the current operation of the reader. The user may manage the upgrade process through the steps described in this section.

Terms and Acronyms

- Client: the user program that uses the upgrade management service
- Primary image: the image that is currently running
- Secondary image: the image that is not running and may be the target of upgrading or fallback.
- Upgrade Configuration: the information for determining the upgrading procedure.
- Upgrade Image File: A file that contains the Speedway reader image used for upgrade. It is stored on a file server and retrieved by the Speedway reader.
- Metafile: The data file that resides on a file server and contains the Upgrade Configuration information.
- Metafile-URI: The Universal Resource Identifier of the metafile.
- URI: Universal Resource Identifier as defined in RFC3986.

Dual Image Model

The flash layout can be viewed as consisting of primary and secondary images, each of which consists of three partitions, as shown in Figure 6-1. The primary image is the image that the reader is currently running and the secondary image is used for upgrade to a new image or fallback to a previous image.

Figure 6-1 Dual Image Model

The three partitions in each image are:

- Partition 0, Speedway OS Partition (SOP). This partition contains the Linux OS image, file system, and Impinj reader application.
- Partition 1, Speedway Configuration Partition (SCP). This partition contains the Impinj reader application configuration and other general configuration data.
- Partition 2, Custom Application Partition (CAP). This partition may contain a custom application.

Partitions 0 and 2 can be individually upgraded, while Partition 1 can be upgraded only when Partition 0 is upgraded. Upgrade is performed in the background, so that the current operation of the reader is not disturbed until the activation of the new image, which is also controlled by the user.

Image Versioning Scheme

Each partition has a four part version number associated with it. In the upgrade configuration file (see section 6.3), the version number is represented by a string consisting of four fields separated by '.' (dot), as follows:

ddd.ddd.ddd.ddd

where each field is a decimal number ranging from 0 to 255. The left-most field is the most significant part of the version number with sub-versions provided to the right. For the purpose of upgrade, when two version numbers are compared, the one with the largest leftmost number is considered a higher version and therefore a newer image. For example, if two versions being compared are 2.3.4.9 and 2.4.4.1, 2.4.4.1 is considered newer because the second number from the left is larger (in this case 4 versus 3). Other than this, the upgrade mechanism assumes no additional meaning to the version string.

6.1. Upgrade Methods

Speedway provides two methods to support software upgrade: push and pull. Push mode is a manual technique to perform an upgrade on an individual reader. Pull mode is an upgrade method that allows simultaneous upgrade of multiple readers through a single Upgrade Configuration file called a metafile. The default configuration of the reader is "push" mode.

In push mode, the Client can trigger a one-time upgrade of the Speedway image. When triggering the upgrade, the Client must specify the location of the Upgrade Image File as a URI. Upgrade will be performed if any of the partitions within the new image are different than those contained in the primary image. Once download and programming has completed, the reader will remain in push mode and will perform no further upgrades until a new client request is issued. In push mode, the reader will not reboot automatically to activate the new image. The Client must issue a reboot command (section 7.3.1) to complete the activation.

In pull mode, the Client creates a custom Upgrade Configuration Metafile (or metafile for short). This metafile is stored on a remove server. The Client configures the location of the metafile as a URI. The reader downloads the data contained in the metafile at periodic intervals (called the retrieve period) and uses that data to make automatic upgrade decisions. The reader remembers the retrieve mode, retrieve period and URI across power-cycles so that it can resume the pull method after a system reboot. Typically when the reader retrieves the metafile at scheduled time (or when it reboots), it will find that no upgrade is needed because, in the absence of any change in the metafile on the server, the image version the reader is running is the same as that specified in the metafile.

6.2. Preparing the Upgrade Image

The path and permission of the image file on the server should be set properly to allow file retrieval via the method as specified by the **upgrade-file-uri** field of the metafile or by the image URI.

6.3. The Upgrade Configuration Metafile

The Upgrade Configuration metafile is at the core of the pull upgrade mechanism. The user prepares this file based on upgrade requirements and saves it on a file server accessible from the reader. The file contains the instructions to the Speedway reader as to how to perform the upgrade as a list of text-based entries. Each data entry consists of a single line data field and may be qualified with one or more parameters separated with a semi-colon. Please note that the metafile must not contain any Unicode characters. Table 6-1 lists the data entries in the metafile. All data fields and parameters are mandatory unless marked as optional.The format of a data entry is as follows:

```
field-name:field-value{;parameter-name=parameter-value} <EOL>
```

Table 6-1   Upgrade Configuration Definition

Field Name	Field Value	Param Name	Param Value	Description
retrieve-mode				This field indicates how the metafile is to be retrieved.
	push			This tells the reader to wait to be given upgrade information directly
	pull	**retrieve-period**	**<int>**	This tells the reader to periodically retrieve the metafile. The mandatory parameter specifies how often (in minutes) the reader downloads the metafile
upgrade-mode				This field indicates how the reader determines the need for upgrade.
	auto			The reader determines if an upgrade is necessary based on its knowledge of the local image version compared to the upgrade file. Upgrade is needed if the local image has at least one partition that has a lower version than the corresponding partition in the upgrade image file.
	forced			The reader should upgrade as long as the current image has at least one partition that has a different version from the corresponding partition in the upgrade image file.
commit-mode				This field indicates how the image should be activated.
	immediate			The image should be activated immediately after the upgrade is complete, causing an immediate reboot after programming is complete.
	wait-4-cmd			The image should be activated by a reboot command from the user.
	scheduled	**time**	**<string>**	Reboot is scheduled at the time indicated by the mandatory parameter **time**. The value of **time** is a string that takes the format of "**<time-zone>:yyyy:mm:dd:hh:mm:ss**" where <time-zone> is **gmt.**
		early-act-ok (optional)	**{no, yes}**	It's OK to activate the upgraded image before its scheduled activation time due to an early reboot. Default value is **no** when this parameter is absent.
dl-retries	**<int>**			Number of times to retry if download fails due to timeout.
dl-retry-period	**<int>**			Time to wait (seconds) before retrying a download.
upgrade-file	**<int>**			This field is used as a delimiter. It means all data fields after this one, up to the next delimiter or end of metafile apply to the upgrade file indexed by the number in the field value **<int>**.
img-type	**<int>**			This field indicates the image type of the upgrade file specified by the **file** field. The type is the enumeration number **<int>**. Release notes will specify the image type. Refer to respective release notes for each image.
upgrade-file-uri	**<string>**			This is the URI of the upgrade image file from which the upgrade image is downloaded.
partition				This field is the partition descriptor in an upgrade file.
	<int>	**version**	**<string>**	Version of the partition, consisting of 4 fields of decimal numbers separated by a dot '.'. The number in each field must be in the range of 0 to 255.

6.4.   Preparing the Upgrade Configuration Metafile

The upgrade configuration metafile is prepared on the server as pointed to by the reader's metafile URI. The data entries in the metafile should follow the format and definition given in section 6.3. Missing mandatory data entries and bad syntax will cause the reader to reject the metafile.

The upgrade image file pointed to by the **upgrade-file-uri** field must contain the same partitions, image types, and versions as described by the **partition** fields in the metafile. Disagreement between the metafile and the upgrade image file will cause the reader to reject the downloaded image file.

The path and permission of the metafile on the server should be set properly to allow file retrieval via the method specified by the URI parameter in the **config image metafile** command as explained in Section 7.4.2.3.

6.5. Image Management Command

6.5.1. Invoking an Upgrade

An upgrade can be triggered in any one of the following scenarios:

- The user can invoke the Rshell command **config image upgrade** to instruct the reader to enter push mode and directly download the upgrade image file from the specified URI and perform an upgrade with the image downloaded. See section 7.4.2.5 for details.

- The user can invoke the Rshell command **config image metafile** to instruct the reader to enter pull mode, download a metafile from the specified URI, and perform an upgrade based on the metafile Regardless of the upgrade status, the reader remembers the URI for future use. See section 7.4.2.3 for details.

- The user can invoke the Rshell command **config image retrievemode** to manually set the retrieve mode of the reader. If the retrieve mode is set to pull via this command and the reader has a valid metafile URI, the reader will immediately attempt to retrieve the metafile via the URI. If metafile retrieval fails, the reader will retry periodically based on the retrieve period specified in the command. See section 7.4.2.4 for details.

6.5.2. Factory Default Restoration

The following command can be used to restore the Speedway reader's factory default configuration settings associated with the currently running image:

- The user can use the Rshell command **config image factory** to return the reader to a factory default configuration. The command retains the current primary SOP, but defaults the reader's configuration and erases the reader's application. See section 7.4.2.1 for details.

6.5.3. Fallback to Previous Image

The following command can be used to fallback or restore the reader's previous image in case something was ill affected by the upgrade procedure:

- The user can invoke the Rshell command **config image fallback** to restore the reader to its previous image. See section 7.4.2.2 for details.

6.5.4. Query the Upgrade Status

The following command is used to query the status of upgrades including factory default and fallback:

- The user can invoke the Rshell command **show image summary** to view the details of the current primary and secondary images. This command also shows the status of pending and completed upgrades as well as error codes indicating the reasons for upgrade failures. See section 7.5.2.1 for details.

- The user can invoke the Rshell command **show image metafile** to view the details of the current retrieve mode and metafile data. See section 7.5.2.1 for details.

6.5.5. Background Execution of Image Management Commands

Some image management commands are executed in the background and are not finished right away. If a previous image management command is still being processed, a subsequent image management command will be rejected with a command response code of "`Previous-Command-In-Progress`". The following image management commands have this behavior:

```
config image metafile
config image upgrade
config image factory
```

During the execution of these image management commands, the **reboot** command will also be rejected with the "Previous-Command-In-Progress" error unless the force option is applied. All other **config image** and **show image** commands are

completed immediately and can be immediately followed by any other image management command.

6.6.   **Upgrade Examples**

Shown below is a capture of command line activity demonstrating a successful upgrade, using the **push** method. (Note that text entries after the # sign are comments.)

```
# Issue a command to upgrade using FTP. Username and password are fake

> config image upgrade ftp://username:password@server1.mydomain.com/binaries/sop-2-0-
1.upg
Status=0,'Success'     # command accepted
> show image summary    # Query status
Status=0,'Success'
UpgradeStatus=Downloading  # Reader determines upgrade is needed and starts download
# Current image info
primaryImageType=1
primaryImageSystemVersion='1.4.2.240'
primaryImageConfigVersion='255.255.255.255'
secondaryImageType=1
secondaryImageSystemVersion='1.4.2.240'
secondaryImageConfigVersion='255.255.255.255'
> show image summary
Status=0,'Success'
UpgradeStatus=Erasing  # Download OK. Erasing secondary flash
primaryImageType=1
primaryImageSystemVersion='1.4.2.240'
primaryImageConfigVersion='255.255.255.255'
secondaryImageType=1
secondaryImageSystemVersion='1.4.2.240'
secondaryImageConfigVersion='255.255.255.255'
>
>
> show image summary
Status=0,'Success'
UpgradeStatus=Programming  # Now programming new image
primaryImageType=1
primaryImageSystemVersion='1.4.2.240'
primaryImageConfigVersion='255.255.255.255'
secondaryImageType=1
secondaryImageSystemVersion='1.4.2.240'
secondaryImageConfigVersion='255.255.255.255'
> show image summary
Status=0,'Success'
UpgradeStatus=Done # programming done successfully
primaryImageType=1
primaryImageSystemVersion='1.4.2.240'
primaryImageConfigVersion='255.255.255.255'
secondaryImageType=1
secondaryImageSystemVersion='2.0.1.240'
 >
 >
 >
# Reader is waiting for reboot to activate the new image. All other activities not
# affected.
 > reboot
Status=0,'Success'
 >
```

```
The system is going down NOW !!
```

6.7. Metafile Examples

Below is an example of a complete metafile (note that the metafile may contain comment lines that start with a pound sign #):

```
##   This is an example upgrade config metafile.
##   Lines commented out with single # are alternative values or additional fields
##   Lines commented out with double ## are explanations
##
##   retrieve-period is in minutes
retrieve-mode:pull;retrieve-period=60
#retrieve-mode:push
upgrade-mode:auto
#upgrade-mode:forced
##   reboot at a scheduled time yyyy:mm:dd:hh:mm:ss
commit-mode:scheduled;time="local.2006:05:08:04:12:32";early-act-ok=yes
#commit-mode:wait-4-cmd
#commit-mode:immediate
##   dl-retries defaults to no-retry if not present.  retry only if failed due to
timeout
#dl-retries:3
##   dl-retry-period is in seconds
#dl-retry-period:60
upgrade-file:0
##   img-type is always 1 for now
img-type:1
upgrade-file-uri:"tftp://fileserver.store.com/impinj-reader-image.upg"
##   partitions and their versions must agree with what's in the image
partition:0;version="2.0.1.240"
#partition:1;version="255.255.255.255"
#partition:2;version="1.0.0.3"
```

6.8. Other URI Examples

The Speedway reader supports three URI schemes for upgrade: TFTP, FTP, and HTTP. The following links provide other examples of URIs:

```
http://httpserver.mydomain.com/impinj/reader-images/upgrade_metafile
tftp://tftpserver.mydomain.com/image-sop-scp-cap-2.1.1.upg
ftp://user:password@ftpserver.mydomain.com/speedway/images/image-sop-scp-cap-
2.1.1.upg
```

As with any remote file retrieval, the servers should be properly configured such that the files are accessible either anonymously or by the specified user from the client (the reader).

6.9. Detailed Upgrade Behaviors

6.9.1. Upgrade file validity check

The reader always checks the following for the validity of the upgrade file:
- Upgrade file format
- Upgrade file CRC
- Hardware compatibility with the reader
- Agreement between the upgrade metafile and the upgrade image, in terms of version number, image type and partitions present.

If the check fails, the upgrade is aborted and the status is reported via the **show image summary** command as explained in

section 7.5.2.1.

6.9.2. Upgrade decision

Not all upgrade attempts will result in an actual upgrade, even if the upgrade file is valid. The reader's upgrade decision is based on the following factors:

- The image versions of the SOP and CAP partition of the primary image.
- The image version(s) of the partition(s) in the upgrade metafile and the upgrade image files downloaded, as well as the number of partitions present.
- The image type of the primary image, as well as the type indicated by the image metafile and upgrade file.
- The upgrade mode, **forced** or **auto**, as indicated in the upgrade metafile.

In **auto** upgrade mode, the upgrade will happen only when either one of the following is true:

- The upgrade image has the same type as the primary image and at least one partition in the upgrade image has a version higher than the corresponding version in primary image. In this case the partition in the upgrade file that has lower version number than the one in primary image will not be used, instead the current primary partition will be kept.
- The upgrade image has different image type from the primary and SOP is present in the upgrade file.

In **forced** upgrade mode, an upgrade will happen as long as at least one partition in upgrade file has a different version from the primary image. If the upgrade is started with **config image upgrade** command, the upgrade is always performed regardless of version numbers.

6.9.3. Partition copy-over

The upgrade image file does not necessarily contain all the partitions. The missing partition(s) will be copied over to the secondary image from the primary image upon reboot after upgrade whenever applicable. The behavior is as follows:

- If the upgrade file has image type same as the primary image, then
  - If the upgrade file contains SOP only, primary SCP and CAP (if present) are copied over.
  - If the upgrade file contains SOP and CAP, primary SCP is copied over.
  - If the upgrade file contains CAP, the primary SOP and SCP are copied over.
  - If the upgrade file contains SOP and SCP, primary CAP, if present, is copied over.
- Else if the upgrade file has a different image type from the primary image, no partition is copied over. The new image will use the factory default configuration if there is no SCP in the upgrade file.

Such copy-over behavior allows the current configuration and custom application to be carried over to the new image after an upgrade.

6.9.4. Image partitions already programmed

There are cases when the partitions in the upgrade file are already on the secondary image. For example, when a reboot is scheduled in 10 hours following a successful upgrade and the reader is pulling the metafile every 10 minutes, it will find that the same partitions in the metafile already programmed on the secondary image. To avoid unnecessary programming of flash, the reader checks if any or all of the intended partitions are already programmed and the behavior in these cases is as follows:

- If the upgrade file contains SOP only and it is already on the secondary image, there is no reprogramming of flash except for marking the primary SCP, and CAP if present, to be copied over upon reboot after upgrade. (See section 6.9.3)
- If the upgrade file contains SOP and CAP and both are already on the secondary image, there is no reprogramming of flash except for marking the primary SCP to be copied over upon reboot after upgrade.
- If the upgrade file contains CAP only and it is already on the secondary image, the primary SOP is copied to secondary image and the primary SCP is marked as to be copied over upon reboot after upgrade.

Note that these behaviors only apply to automatic upgrades performed via the periodic pull method with auto or forced upgrade mode. When the upgrade is manually pushed with the **config image upgrade** command, the flash is always programmed with the upgrade image regardless of the versions on the primary and secondary images.

7. Rshell Command Line Interface

The Speedway reader's Rshell Command Line Interface (CLI) is accessed via serial, Telnet, or SSH connectivity. A graphical representation of the command structure is shown in Figure 7-1.
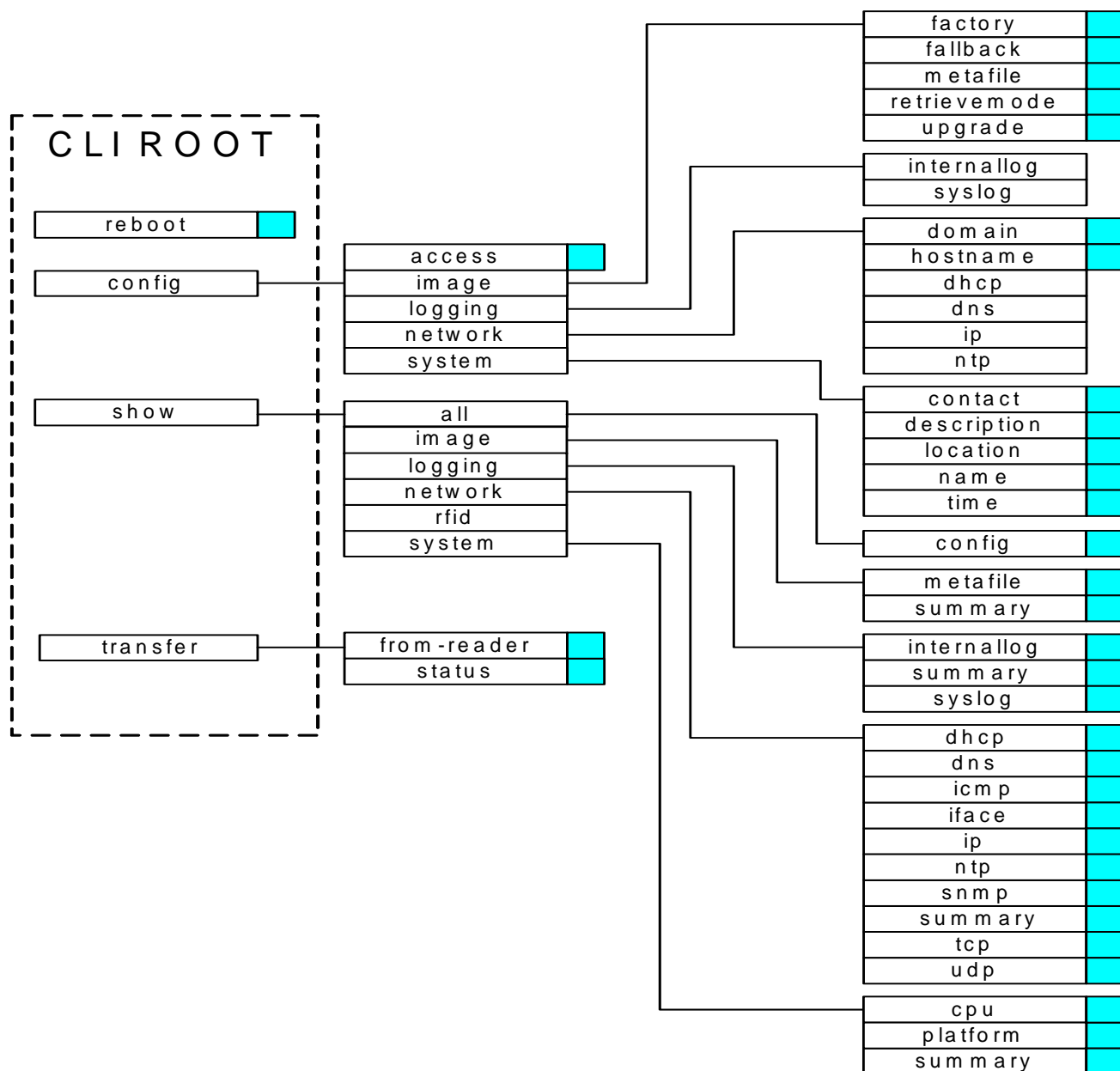
Figure 7-1   Command Line Interface Tree

7.1.   Rshell Overview

Users may navigate to any of the menus simply by entering the menu name at the Rshell prompt, as shown below:

```
> show network
show network >
```

At all menus, the **help** command (or simply **?**) will list all the commands available from the active menu, as well as the submenus that can be accessed from the active menu.

```
> help

Commands:
osshell  - Starts an OS shell for direct access to reader.
reboot   - Reboots the system.
exit     - Exit this submenu and return to the parent menu.
help     - Displays this help message.
?        - Displays this help message.

Sub-menus:
config   - Submenu of configuration commands.
show     - Submenu of elements that may have their configuration or
           status shown.
transfer - Submenu of transfer commands.
```

Menu navigation and the **help** keyword (or **?**) can be combined on the same line to list all the commands available for that menu. For example:

```
> config ?

Commands:
access  - Changes the password for a given access level.
CLI     - Not handled yet
rfid    - Not handled yet
exit    - Exit this submenu and return to the parent menu.
help    - Displays this help message.
.       - Exit this submenu and return to the parent menu.
?       - Displays this help message.

Sub-menus:
image   - Submenu of image and upgrade configuration commands.
logging - Submenu of logging configuration commands.
network - Submenu of network configuration commands.
system  - Submenu of system info configuration commands
 >
```

At all menus, entering the **help** command or **?** prior to a command or menu, will return the syntax for its usage. For example:

```
> ? config

config   - Submenu of configuration commands.
Usage:  config  [<subcommand> ...]

 >
```

or

```
 > ? config access

config   - Submenu of configuration commands.
Usage:   config  [<subcommand> ...]

access   - Changes the password for a given access level.
Usage:   config access <level> <password>
         <level> is one of: root readonly readwrite (currently only
         root is supported)
         <password> is any text, please use at least six characters.

 >
```

Entering the **?** between a menu and sub-menu/command will return the usage for all items following the **?**. In the example below, **image** is a menu that contains commands of its own.

```
 > config ? image factory

image    - Submenu of image and upgrade configuration commands.
Usage:   image  [<subcommand> ...]

factory - Revert to factory defaults.
Usage:   image factory

 >
```

Required parameters are indicated by angle brackets (e.g. <parameter>), while optional parameters are indicated by square brackets (e.g. [parameter]). At all menus, the **exit** command or simply '**.**' will return the user to the previous menu context. To exit Rshell and terminate the user session (serial, telnet, or SSH), the **exit** command must be executed from the root menu:

```
show network> exit
show>
```

For machine execution, all commands can be called from the root menu. For example:

```
 > show network
show network> dns
```

is equivalent to:

```
 > show network dns
```

All commands return data in machine/human readable format.

7.2. Error Codes

The first line of every response has the following format:

```
Status=errorCode,'error string'

Where errorCode is a numberic value and 'error string' is a single-quoted human
readale error code. The error codes are defined in Table 7-1.
```

Table 7-1 Error Codes

Error Code	Error String	Description
0	Success	
1	Invalid-Command	Command could not be parsed and identified as one of the commands supported by the interface
2	Invalid-Command-Parameter	One or more parameter types was unrecognized for this command
3	Invalid-Parameter-Value	One or more parameter values was illegal or out-of-range for this command
4	Parameter-Dependency-Error	Parameter value or combination was invalid in combination with other parameters or values
5	Incomplete-Parameter-List	The parameter list was incompletely specified and the command cannot be executed
6	System-Resource-Limit	Command could not be executed due to a resource limit on the box (e.g., could not add a 4th trap receiver because the device only supports three)
7	Unsupported-Command	Reserved for Future commands
8	Permission-Denied	User does not have permission to access this command
9	Previous-Command-In-Progress	The command was rejected because a previous command is still in progress such that this one could not be processed
10	Command-Being-Processed	The command cannot be finished right away; it is being processed.

A sample error parameter string is shown below:

```
> typographical_error
Status=1,'Invalid-Command'
```

When a command's action requires return parameters, they follow the error status, one parameter per line, and in the following format:

```
parameterName=value0
parameterName=value1
…
parameterName=value9
```

The specific response parameters are detailed in the sections that follow.

7.3. Root Menu

Referring to Figure 7-1, the root menu contains the **reboot** command, and links to the **config**, **show**, and **transfer** sub-menus.

7.3.1. reboot Command

The **reboot** command instructs the reader to reboot. This may be used after a manual upgrade of the reader's firmware or application software. The **reboot** command may also contain an optional argument **force** that will cause the reader to reboot even if a current operation is pending (such as a firmware download). If the **force** argument is absent, the reader will reject the command if a current download is in progress. A help command entered at the command line interface will return the following usage instruction:

```
> help reboot
reboot   - Reboots the system.
Usage:   reboot [force]
```

7.3.2. config Command

The **config** command leads to a submenu of configuration commands described further in section 7.4.

7.3.3. show Command

The **show** command leads to a submenu of elements that may have their configuration or status shown. See section 7.5.

7.3.4. transfer Command

The **transfer** command leads to a submenu of transfer commands described further in section 7.6.

7.4. Config Command

If a **help config** command is entered at the command line interface, the system will respond as follows to indicate the need to enter subcommands:

```
> help config
config   - Submenu of configuration commands.
Usage:  config [<subcommand> ...]
```

Entering the **config** command, followed by help (or ?), brings up a submenu of configuration commands.

```
> config
config > ?

Commands:
access       - Changes the password for a given access level.
CLI          - Not handled yet
rfid         - Not handled yet
exit         - Exit this submenu and return to the parent menu.
Help         - Displays this help message.
.            - Exit this submenu and return to the parent menu.
?            - Displays this help message.

Sub-menus:
image        - Submenu of image and upgrade configuration commands.
logging      - Submenu of logging configuration commands.
network      - Submenu of network configuration commands.
system       - Submenu of system info configuration commands.
```

7.4.1. config access Command

The **config access** command changes the password for a given access level. Only root is supported at present. Password changes made via this command also change the users web password to the same value.

Table 7-2   "config access" Command Parameters

Arguments	Options	Format	Description
Level	Root	STRING	Level of user to change (only root is supported)
Password		STRING	Password to set account's active password to (at least six characters).

The command usage is shown below:

```
Usage:  access <level> <password>
```

A sample of the command and response is shown below:

```
> config access root MyPassword
Status=0,'success'
```

7.4.2.   config image Command

The config image commands provide configuration options for image and upgrade configurations. It contains no sub-menus.
The commands are described below:

```
Commands:
factory        - Revert to factory defaults.
fallback       - Fallback to the previous image (if valid).
metafile       - Perform an upgrade with a given metadata URI.
retrievemode   - Perform an upgrade with a given URI.
upgrade        - Perform an upgrade with a given URI.
exit           - Exit this submenu and return to the parent menu.
help           - Displays this help message.
.              - Exit this submenu and return to the parent menu.
?              - Displays this help message.

Sub-menus:
None
```

Note that these commands will not take effect until the reader is rebooted. Detailed explanation of image upgrade is given in section 6.

7.4.2.1. config image factory Command

This command, followed by a reboot, reverts the reader to factory default configuration associated with the current running image, and at the same time, removes the custom application partition. Once complete, the factory defaults do not take effect until the system is rebooted. This command takes no parameter. Example command usage is shown below:

```
Usage:  config image factory
```

During factory default, the **show image summary** (section 7.5.2.1) command reports the **UpgradeStatus** as Erasing, Programming, or Done. After this command is processed, the reader will continue its operation with the current configuration until a reboot command is issued. In the mean time, the metafile retrieve-mode is set to push, i.e., the factory default restore command cancels a previously scheduled periodic upgrade. When the reader comes up from the reboot, it will run the same SOP image version as the one it performed the factory default restore from with factory default configuration and no custom application.

If the reader is in pull mode during the execution of this command, it is possible that the reader is currently retrieving the metafile or performing an upgrade. In these instances, this command may return "`Previous-Command-In-Progress`".

7.4.2.2. config image fallback Command

The successful processing of this command, followed by a reboot, reverts the reader to the previous valid image. This command takes no parameter.

If there is no valid previous image to fallback to, the command response will be "failure" with a reason "No Fallback Image Available ", as listed in Table 7-14. After this command is successfully processed, the reader waits for a reboot command to fallback to the previous image. In the mean time, the reader operates normally except that all the **config image** commands will be rejected with a reason "Current Image Invalidated". Also the metafile retrieve-mode is set to push, i.e., the fallback command cancels a previously scheduled periodic upgrade. When the reader is rebooted, the previous image will be activated.

If the reader is in pull mode during the execution of this command, it is possible that the reader is currently retrieving the metafile or performing an upgrade. In these instances, this command may return "`Previous-Command-In-Progress`".

Note: a fallback will utilize all the old configuration settings, including the upgrade metafile settings as if the upgrade to the newer image was never performed—which may trigger an immediate upgrade. If the URI of the old metafile is known and an immediate upgrade is not desired, the user should remove or rename the old metafile before performing a fallback.

```
        Usage:   config image fallback
```

7.4.2.3. config image metafile Command

This command takes the Universal Resource Identifier (URI) of the upgrade configuration metafile as the parameter. It commands the reader to perform an upgrade using the metafile identified by the URI.

```
        Usage:   config image metafile <URI>
```

Upon receiving this command, the reader updates its local upgrade configuration URI, retrieves the upgrade configuration metafile, and performs the upgrade in accordance with the metafile. If the upgrade is successful, how the new image is activated depends on the commit-mode specified in the metafile (see Section 6.1).

If the reader is in pull mode during the execution of this command, it is possible that the reader is current retrieving the metafile or performing an upgrade. In these instances, this command may return "`Previous-Command-In-Progress`".

7.4.2.4. config image retrievemode Command

This command sets the reader's metafile retrieve mode and, if applicable, retrieve period. See Table 7-3. When the retrieve-mode is set to push, the reader will take no upgrade action. To perform an upgrade in this mode the user must issue a **config image upgrade** command to directly download an upgrade image. (See section 7.4.2.5).

```
    Usage:   retrievemode push
             retrievemode pull <period-minutes>
             <period-minutes> is how often the reader pulls the metafile
             from the most recently specified <URI>.
```

Table 7-3 "config image retrievemode" Command Parameters

Argument	Options	Format	Description
mode	<pull | push>	STRING	When the mode is pull, the reader periodically retrieves the metafile from the most recently set metafile URI at the rate specified by the retrieve-period. In push mode the user must manually specify a new metafile URI or manually upgrade the file to perform the upgrade.
retrieve-period		INT	Interval of pull in minutes — only applicable when mode is pull. This retrieve period is used only until the reader retrieves a valid metafile, at which point the retrieve period from the metafile is adopted.

If this command results in a change from push to pull, or a change of *retrieve-period* while current mode is pull, the reader immediately attempts to download a new UConf metafile using its current metafile URI.

7.4.2.5. config image upgrade Command

This command is used to instruct the Speedway reader to directly download an upgrade image file and perform an immediate upgrade. Upgrade image files are stored on a file server and retrieved by the Speedway reader from the location identified by the URI.

```
        Usage:   config image upgrade <URI>
```

Upon receiving this command, the Speedway reader downloads the image file and, if the file is valid and eligible, performs the upgrade. When this command is used, the upgrade will always be performed even if the version matches the current one.

If the upgrade is successful, the new image is not activated until the user reboots the system.

If the reader is in pull mode during the execution of this command, it is possible that the reader is currently retrieving the metafile or performing an upgrade. In these instances, this command may return "`Previous-Command-In-Progress`".

Note that this command does not change the reader's upgrade configuration URI, but it sets the retrieve-mode to push, meaning that the reader will not periodically retrieve upgrade configuration metafile until the retrieve-mode is set to pull again. See section 7.4.2.4.

7.4.3. config logging Menu

The **config logging** commands provide configuration options for remote syslog capture as well as internal Impinj log capture via sub-menus. Logging levels may be set to one of eight options (in decreasing order from most severe to least): emergency, alert, critical, error, warning, notice, info, and debug. Which data are forwarded from the internal Impinj (**internallog**) log capture to the remote system logging (**syslog**) depends on the relative level settings. For example, if the **internallog** is set to the level of "critical", and the **syslog** level is set to "debug", then all internal log data will be sent to the remote system capture because the severity level of the internal Impinj log data will always be greater than the remote system log. Conversely, if the **internallog** is set to "info" and the **syslog** is set to "alert", then only internal log data with severity level of "alert" and higher will be forwarded. The internallog data is still accessible via Rshell but it will not be stored in the syslog. See Figure 7-2.

The commands are described below:

```
Commands:
Exit          - Exit this submenu and return to the parent menu.
Help          - Displays this help message.
.             - Exit this submenu and return to the parent menu.
?             - Displays this help message.

Sub-menus:
internallog - Submenu of internal logging specific commands.
syslog      - Submenu of syslog specific commands.
```

Internal log   Syslog

Logging
Data

| emergency |
| alert |
| critical |
| error |
| warning |
| notice |
| info |
| debug |

| emergency |
| alert |
| critical |
| error |
| warning |
| notice |
| info |
| debug |

Severity
Levels

Internal log   Syslog

Logging
Data

| emergency |
| alert |
| critical |
| error |
| warning |
| notice |
| info |
| debug |

| emergency |
| alert |
| critical |
| error |
| warning |
| notice |
| info |
| debug |
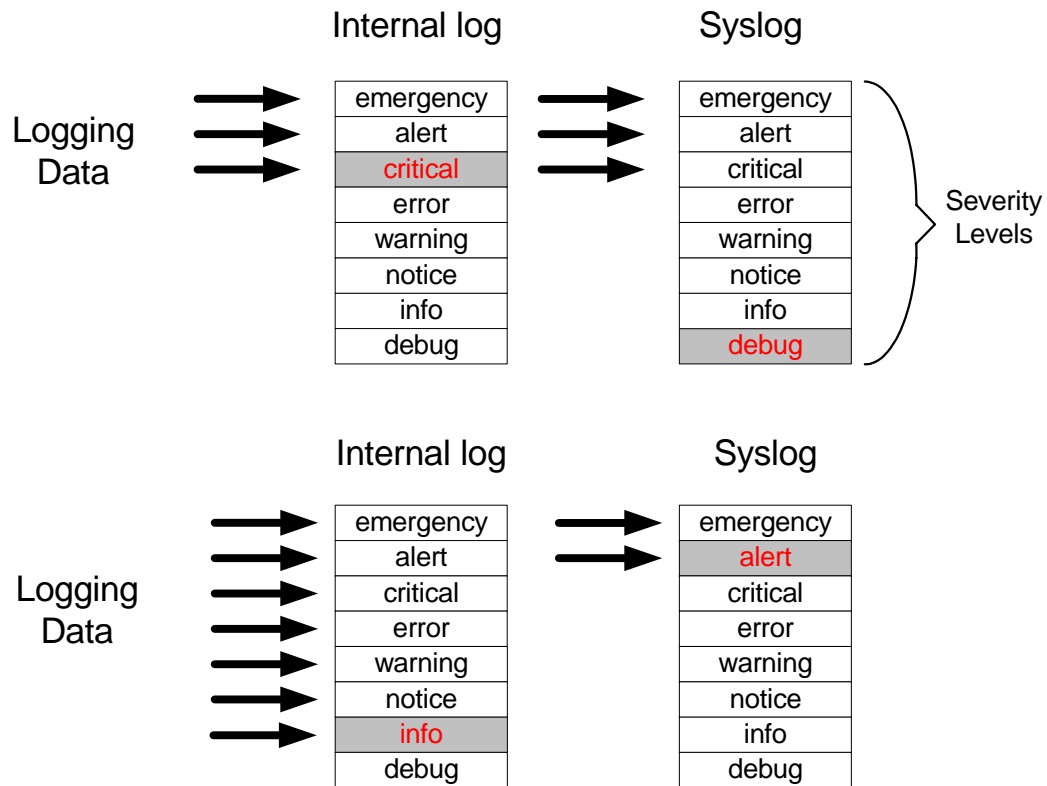
Figure 7-2 Relative Severity Level Logging Transfer

7.4.3.1. config logging internallog Commands

The **config logging internallog** commands set the internal logging level for reader log events. These events can be viewed via the **show logging** command or transferred off the reader via the **transfer** command. The **set** command sets the logging level for a log class to one of a set of pre-defined values.

```
Commands:
set   - Configures internal logs.
exit  - Exit this submenu and return to the parent menu.
help  - Displays this help message.
.     - Exit this submenu and return to the parent menu.
?     - Displays this help message.

Sub-menus:
None
```

Table 7-4 "config logging internallog" Command Parameters

Arguments	Options	Format	Description
ApplicationLevel	<Emergency | Alert | Critical | Error | Warning | Notice | Info | Debug>	STRING	Configures the level at and above which ApplicationLevel logs are sent to the log database. Listing in decreasing order of severity.
ConfigurationLevel	…	STRING	…
MgmtLevel	…	STRING	…
NetworkLevel	…	STRING	…
RFIDParameters	…	STRING	…
RFIDSingulation	…	STRING	…
RFIDAccess	…	STRING	…
System	…	STRING	…

Usage for the **config logging internallog set** command is shown below:

```
Usage:  config logging internallog set <className> <level>

<className> is (ApplicationLevel | ConfigurationLevel | MgmtLevel |
   NetworkLevel | RFIDParmeters | RFIDSingulation | RFIDAccess | System)

<level> is (emergency|alert|critical|error|warning|notice|info|debug)
```

A sample command that sets the RFID Access logging is shown below:

```
> config logging internallog set RFIDAccess emergency
Status=0,'Success'
```

7.4.3.2. config logging syslog Commands

The **config logging syslog** menu provides the configuration interface for the syslog module on the reader. If all remote syslog servers are removed the reader will begin to log in its internal memory.

```
Commands:
add   - Add a server to the list of current syslog servers.
del   - Delete a server from the list of current syslog servers.
delall- Delete all current servers.
level - Change the severity level of the messages to log via syslog.
reset - Removes all archived syslog messages.
exit  - Exit this submenu and return to the parent menu.
help  - Displays this help message.
.     - Exit this submenu and return to the parent menu.
?     - Displays this help message.

Sub-menus:
None
```

Table 7-5 "config logging syslog" Command Parameters

Arguments	Options	Format	Description
add	\<IpAddress| hostname\>	STRING	Add a new syslog server with the following address
del	\<IpAddress| hostname\>	STRING	Delete a syslog server with the following address
delall			Delete all syslog servers
level	\<Emergency | Alert | Critical | Error | Warning | Notice | Info | Debug\>	STRING	Set the syslog security level. Only logs at or greater in severity than this level will be forwarded to syslog. Levels listed in order of decreasing severity.
reset			Removes all archived syslog messages.

Usage of the commands are shown below:

```
Usage:  config logging syslog add <server-name>
Usage:  config logging syslog del <server-name>
Usage:  config logging syslog delall
Usage:  config logging syslog level <level>
Usage:  config logging syslog reset
```

A sample command is shown below:

```
> config logging syslog add 10.0.10.37
Status=0,'Success'

> config logging syslog del 10.0.10.37
Status=0,'Success'

> config logging syslog level warning
Status=0,'Success'

> config logging syslog reset
Status=0,'Success'
```

7.4.4. config network Menu

The **config network** menu allows the user to administer and manually provision the network settings for the reader. This menu provides the following commands:

```
Commands:
domain   - Set the domain of the reader.
hostname - Set the reader hostname.
snmp     - Not handled yet.
exit     - Exit this submenu and return to the parent menu.
help     - Displays this help message.
.        - Exit this submenu and return to the parent menu.
?        - Displays this help message.
```

```
Sub-menus:
dhcp     - Submenu of DHCP specific commands.
dns      - Submenu of DNS specific commands.
ip       - Submenu of IP address and configuration commands.
ntp      - Submenu of NTP specific commands.
```

7.4.4.1. config network domain Command

The **config network domain** command configures a search domain on the reader device. This domain will be used if the DHCP network does not provide a search domain to the device or the IP address mode is static.

Table 7-6   "config network domain" Command Parameters

Command	Options	Format	Description
domain		STRING	Configures a static search domain for the reader. If DHCP is used, this static domain is not used. If the IP address mode is turned to static, this domain will be put to use. If the STRING is absent, this command deletes the static search domain.

The command usage is shown below:

```
Usage:  config network domain <domain-name>
```

A sample of the command and response is shown below:

```
> config network domain bar.com
Status=0,'success'
```

7.4.4.2. config network hostname Command

The **config network hostname** command configures a hostname on the reader device—the hostname to be used if the DHCP network does not provide a hostname to the device.

Table 7-7   "config network hostname" Command Parameters

Command	Options	Format	Description
hostname		STRING	Configures the current hostname for the reader. Parameters returned from DHCP will override this value.

The command usage is shown below:

```
Usage:  config network hostname <host-name>
```

A sample of the command and response is shown below:

```
> config network hostname speedwayc11
Status=0,'success'
```

7.4.4.3. config network dhcp Command

The **config network dhcp** command allows the user to modify the DHCP client configuration. The commands are described below.

```
Commands:
sendhostname     - Turn on/off send-hostname in DHCP client config.
userclass        - Set the user class option of DHCP client config.
exit             - Exit this submenu and return to the parent menu.
help             - Displays this help message.
.                - Exit this submenu and return to the parent menu.
?                - Displays this help message.
```

```
        Sub-menus:
        None
```

Command parameters are shown in Table 7-8.

Table 7-8 "config network dhcp" Command Parameters

Commands	Arguments	Format	Description
Sendhostname	<on | off>	STRING	Turn the "send hostname" on/off option in the DHCP client configuration
Userclass		STRING	Sets the value for the "send user-class" option of the DHCP client configuration. Issuing this command without giving a userclass string turns this option off.

The command usage is shown below:

```
        Usage:  config network dhcp sendhostname <on|off>
        Usage:  config network dhcp userclass [<value>]
```

The result of issuing this command is as follows:
- If the sendhostname DHCP option is currently off and the command turns it on, the network interface is "refreshed", i.e., the DHCP client is restarted and the DHCP request is resent to get an IP address.
- If the userclass option is turned on, or its value is changed, the network interface is refreshed.

7.4.4.4. config network dns Command

The **config network dns** command allows the user to statically configure DNS servers. These servers are in addition to any provisioned through DHCP.   The commands are described below.

```
        Commands:
        add        - Add a static server to the list of current DNS servers.
        del        - Delete a statically configured server from the list of
                     current DNS servers.
        delall     - Delete all statically configured DNS servers.
        exit       - Exit this submenu and return to the parent menu.
        help       - Displays this help message.
        .          - Exit this submenu and return to the parent menu.
        ?          - Displays this help message.

        Sub-menus:
        None
```

Command parameters are shown in Table 7-9:

Table 7-9 "config network dns" Command Parameters

Command	Arguments	Format	Description
add	IpAddress	IpAddress	Add a static DNS server with the following address. Manually configured DNS servers will be utilized after searching DNS servers returned by DHCP.
del	IpAddress	IpAddress	Delete a statically configured DNS server with the following address. Servers obtained through DHCP are not available for delete.
delall			Delete all statically configured DNS servers added with the add command.

The command usage is shown below:

```
Usage:   config network dns add <server-ip-address>
Usage:   config network dns del <server-ip-address>
Usage:   config network dns delall
```

A sample command and response is shown below:

```
>config network dns add 1.2.3.4
Status=0,'success'
```

7.4.4.5. config network ip Command

The **config network ip** command allows the user to statically configure IP settings, or configure the reader to use DHCP. The commands are described below.

```
Commands:
dynamic - Set the reader to DHCP for IP address parameters.
static  - Set the reader to static IP address parameters.
exit    - Exit this submenu and return to the parent menu.
help    - Displays this help message.
.       - Exit this submenu and return to the parent menu.
?       - Displays this help message.

Sub-menus:
None
```

The parameter table for this command is shown in Table 7-10:

Table 7-10 "config network ip" Command Parameters

Commands	Arguments	Format	Description
static	IpAddress netmask gateway-address broadcast-address		Configure the network for static address resolution. The following combinations of parameters are valid: <IpAddress> <Ip Address> <gateway-address> <Ip_Address> <netmask> <gateway-address> <broadcast-address> For parameters not specified the reader will use default values.
dynamic			Configures the network for dynamic address resolution using the DHCP protocol.

The usage for this command is shown below:

```
Usage:   config network ip static <ip-address>

Usage:   config network ip static <ip-address> <gateway-address>

Usage:   config network ip static <ip-address> <netmask> <gateway-address>
<broadcast-adddress>

Usage:   config network ip dynamic
```

A sample of the command and response is shown below:

```
> config network ip dynamic
Status=0,'success'

> config network ip static 192.168.20.116
Status=0,'Success'
 > show network summary
Status=0,'Success'
ipAddressMode=static
ipAddress=192.168.20.116
ipMask=255.255.255.0
gatewayAddress=192.168.20.1
broadcastAddress=192.168.20.255
hostname=speedwayc11

> config network ip static 192.168.20.116 255.255.255.0 192.168.20.1
192.168.20.255
Status=0,'success'
 > show network summary
Status=0,'success'
ipAddressMode=static
ipAddress=192.168.20.116
ipMask=255.255.255.0
broadcastAddress=192.168.20.255
gatewayAddress=192.168.20.1
hostname=speedwayc11
>
```

7.4.4.6. config network ntp Command

The **config network ntp** command allows the user to statically configure NTP servers. These servers are in addition to any provisioned through DHCP. The commands are shown below:

```
Commands:
add       - Add a static server to the list of current NTP servers.
del       - Delete a statically configured server from the list of
            current NTP servers.
delall    - Delete all statically configured NTP servers.
exit      - Exit this submenu and return to the parent menu.
help      - Displays this help message.
.         - Exit this submenu and return to the parent menu.
?         - Displays this help message.

Sub-menus:
None
```

The command parameters are shown in Table 7-11:

Table 7-11   "config network ntp" Command Parameters

Command	Arguments	Format	Description
add	<IpAddress|hostname>	STRING	Add a static server to the list of current NTP servers.
del	<IpAddress|hostname>	STRING	Delete a statically configured server from the list of current NTP servers.
delall			Delete all the statically configured NTP servers.

The command usage is shown below:

```
Usage:  config network ntp add <server-name>
Usage:  config network ntp del <server-name>
Usage:  config network ntp delall
```

A sample of the command and response is shown below:

```
> config network ntp add yourservername.com
> Status=0,'success'
>
```

7.4.5. config system Menu

This menu allows configuration of the system identification parameters. Commands are shown below:

```
Commands:
contact      - Configure the system contact.
description  - Configure the system description.
location     - Configure the system location.
name         - Configure the system name.
time         - Configure the system time.
exit         - Exit this submenu and return to the parent menu.
help         - Displays this help message.
.            - Exit this submenu and return to the parent menu.
?            - Displays this help message.

Sub-menus:
None
```

All system parameters are entered as strings except for **time**. Place single quotes around strings that have white space. **Time** must be entered in one of the following formats:

```
MMDDhhmm
MMDDhhmmCCYY
MM.DD-hh:mm:ss
CCYY.MM.DD-hh:mm:ss
CCYY.MM.DD-hh:mm
hh:mm:ss
hh:mm
```

Usage for the **config system** commands is shown below:

```
Usage:  config system contact <contact-string>
Usage:  config system description <description-string>
Usage:  config system location <location-string>
Usage:  config system name <system-name-string>
Usage:  config system time <correctly formatted time>
```

A sample **config system** command is shown below:

```
config system > location 'a specific location identifier'
Status=0,'Success'
sysDesc="Impinj Speedway"
sysContact="http://www.supplier.com/techsupport"
sysName="speedway-00-00-06"
sysLocation="a specific location identifier"
time="Tue Apr 25 03:59:00 UTC 2006"
```

A sample command that sets **time** is shown below: (Time is set to April, 27th 1:11:00 p.m. 2006.)

```
> config system time 042713112006

Status=0,'Success'
sysDesc="Impinj Speedway"
sysContact="http://www.supplier.com/techsupport"
sysName="speedway-00-00-06"
sysLocation="a specific location identifier"
time="Thu Apr 27 13:11:00 UTC 2006"
```

7.5. Show Command

If a **help show** command is entered at the command line interface, the system will respond as follows to indicate the need to enter subcommands:

```
> help show
show   - Submenu of elements that may have their configuration or status
         shown
Usage: show [<subcommand> ...]
```

The **show** command brings up a submenu of configuration commands.

```
Commands:
CLI     - Not handled yet
exit    - Exit this submenu and return to the parent menu.
help    - Displays this help message.
.       - Exit this submenu and return to the parent menu.
?       - Displays this help message.

Sub-menus:
all     - Submenu of multi-category info display commands.
image   - Submenu of image status commands.
logging - Submenu of logging status commands.
network - Submenu of network status commands.
rfid    - Submenu of RFID status commands.
system  - Submenu of system status commands.
```

7.5.1. show all

The **show all** menu has the commands listed below.

```
Commands:
config - Summary of reader configuration.
exit    - Exit this submenu and return to the parent menu.
help    - Displays this help message.
.       - Exit this submenu and return to the parent menu.
?       - Displays this help message.

Sub-menus:
None
```

7.5.1.1. show all config

show all config is a summary of the static configuration entries of all categories. The static configuration entries are those that are manually set via CLI commands. The entries that are obtained via such protocols as DHCP are considered dynamic and are not displayed. The response of the command is the concatenation of all the static entries from the following four categories: network, system information, upgrade agent, and logging. Each category is preceded with a delimiter field. The entire collection of possible parameters is listed in Table 7-12. Note that some parameters are present only when set and applicable. The command usage for **show all config** is shown below:

```
Usage:  show all config
```

Table 7-12   "show all config" Response Parameters

Parameter Name	Format	Description
ConfigCategory	Network	This delimits the network category
DomainStatic	STRING	The statically set domain
NnsServerAddress<n>Stat	IP Address	The *n*th static DNS server address. *n* starts with 1.
NtpServerAddress<n>Stat	IP Address	The *n*th static NTP server address, *n* starts with 1.
IpAddressMode	<dynamic | static>	The IP address mode. Dynamic means DHCP is used to obtain IP address.
IpAddress	IP Address	The IP address of the reader's Ethernet interface. Present only if ipAddressMode is static.
IpMask	IP Address	The IP subnet mask of the Ethernet interface. Present only if ipAddressMode is static.
GatewayAddress	IP Address	The default gateway IP address of the Ethernet interface. Present only if the ipAddressMode is static.
BroadcastAddress	IP Address	The broadcast address of the Ethernet interface. Present only if the ipAddressMode is static.
Hostname	STRING	The hostname of the reader
DhcpSendHostname	<on | off>	Indicates if the "send hostname" option of DHCP client configuration is turned on
DhcpUserclass	DisplayString	Displays the user-class option of the DHCP client configuration. DisplayString is empty if this option is not set.
ConfigCategory	SystemInfo	This delimits the system info category
SysDesc	DisplaySring	The system description
SysContact	DisplaySring	The system contact
SysName	DisplaySring	The system name
SysLocation	DisplaySring	The system location
ConfigCategory	UpgradeAgent	This delimits the upgrade agent category
MetafileUri	DisplayString	The URI of the upgrade metafile
RetrieveMode	<pull | push>	The upgrade agent's metafile retrieve mode
RetrievePeriod	INTEGER	The retrieve-period in minutes. Present only if the RetrieveMode is pull.
ConfigCategory	Logging	This delimits the logging category
ApplicationLevel ConfigurationLevel MgmtLevel NetworkLevel RFIDParameters RFIDSingulation RFIDAccess System	<Emergency| Alert | Critical | Warning | Notice | Info | Debug>	The individual component's syslog logging level, as returned by the "show logging summary" command.
SeverityLevel	Same as above	The syslog logging severity level as set by the "config logging syslog level" command
SyslogServerAddress1	IP Address or STRING	The first syslog server as set by the "config logging syslog add" command.
…	…	…
SyslogServerAddress<N>	IP Address or STRING	The last syslog server as set by the "config logging syslog add" command.

```
show all > config
Status=0,'success'
ConfigCategory=Network
domainStatic=
ipAddressMode=dynamic
hostname=speedway-00-02-01
sendHostname=on
userClass=''

ConfigCategory=SystemInfo
sysDesc='Impinj Speedway'
sysContact='unknown'
sysName='speedway-00-02-01'
sysLocation='unknown'
sysTime='Mon Aug 14 20:38:00 UTC 2006'

ConfigCategory=UpgradeAgent
MetafileUri=' '
RetrieveMode=push

ConfigCategory=Logging
ApplicationLevel=emergency
ConfigurationLevel=emergency
MgmtLevel=emergency
NetworkLevel=emergency
RFIDParameters=emergency
RFIDSingulation=emergency
RFIDAccess=emergency
System=emergency
```

7.5.2. show image Command

The **show image** sub-menus commands are shown below:

```
Commands:
metafile - Command to display upgrade metafile info.
summary  - Command to display current image status.
exit     - Exit this submenu and return to the parent menu.
help     - Displays this help message.
.        - Exit this submenu and return to the parent menu.
?        - Displays this help message.

Sub-menus:
None
```

7.5.2.1. show image metafile Command

The **show image metafile** command displays the information for the current upgrade metafile. If no metafile has ever been successfully downloaded, only the first two fields are available. The command usage is shown below:

```
Usage:  show image metafile
```

Table 7-13 "show image metafile" Response Parameters

Parameter Name	Format	Description
MetafileUri	STRING	The current upgrade metafile URI
RetrieveMode	<pull | push>	The current retrieve mode
RetrievePeriod	INTEGER	The current retrieve period, present only if retrieve mode is pull. This is specified in seconds.
UpgradeMode	<auto | force>	The upgrade mode if metafile is currently available
CommitMode	< immediate | scheduled | wait-4-cmd>	The commit mode if metafile is currently available
CommitTime	DisplayString	The schedule commit time, present only if commit mode is scheduled. Its format is <timezone-yyyy-mm-dd-hh-mm-ss>, where time zone is the readers time which is gmt.
EarlyActivateOk	<yes | no>	Indicates whether an early activation of the upgrade image is valid when the commit is scheduled. Present only if the metafile has the early-act-ok field.
UpgFileUri	DisplayString	The upgrade file URI, present if the current metafile is available and has the upgrade-file-uri field.

7.5.2.2. show image summary Command

The **show image summary** command specifies the image summary information. The command usage is shown below:

```
Usage:   show image summary
```

The command returns the following (with all response parameters defined in Table 7-14):

```
> show image summary
Status=0,'Success'
UpgradeStatus=Download Failed
Reason=File Not Found
DownloadFile=Upgrade Image
primaryImageType=1
primaryImageSystemVersion='2.0.1.240'
primaryImageConfigVersion='255.255.255.255'
secondaryImageType=1
secondaryImageSystemVersion='2.0.1.48'
secondaryImageConfigVersion='255.255.255.255'
```

Table 7-14   "show image" Response Parameters

Parameter Name	Format	Description
UpgradeStatus	The upgrade status of the last executed upgrade	
	<Idle |	The reader is idle in terms of upgrade.
	Contacting Server |	Contacting server: reader is contacting server for file download.
	Downloading |	Downloading: File is being downloaded.
	Download Failed |	Download Failed: Failed to download either the metafile or the upgrade image.
	Bad Config |	Bad Config: The upgrade configuration metafile is invalid.
	Bad Image |	Bad Image: The image downloaded is invalid.
	No Upgrade |	No Upgrade: No need to upgrade
	Erasing |	Erasing: Reader is erasing flash memory before writing new image.
	Programming |	Programming: Reader is programming new image into flash memory.
	Done |	Done: Upgrade is complete.
	Set Metafile Failed |	Set Metafile Failed: The configureUri command failed.
	Set Upgrade Failed |	Set Upgrade Failed: The updateUri command failed.
	FDR Failed |	FDR Failed: The factory command failed.
	Set RetrieveMode Failed |	Set RetrieveMode Failed: The retrievemode command failed.
	Failed >	Failed: Any other failures not covered above. Usually explained by Reason field
Reason	This supplements the upgradeStatus field to give a reason for the status	
	<Unknown Host |	Unknown Host: Download failed due to unknown host.
	Unsupported Scheme |	Unsupported Scheme: Download failed due to unsupported URI scheme (only FTP, HTTP and TFTP are supported).
	Syntax Error |	Syntax Error: Metafile has syntax error.
	Timeout |	Timeout: download timed out.
	File Not Found |	File Not Found: Download file not found.
	Access Denied |	Access Denied: Download failed due to access denied by server, e.g., bad password.
	Not Matching Metafile |	Not Matching Metafile: Bad upgrade image due to its not matching metafile.
	Bad File Format |	Bad File Format: Bad upgrade image file format.
	Bad CRC |	Bad CRC: Bad image CRC.
	Bad Hw Version |	Bad Hw Version: Image Hw version not matching the reader.
	No Newer Version |	No Newer Version: Upgrade not needed due to no newer version in metafile or upgrade image.
	File Mismatch |	File Mismatch: Metafile has mismatched partition image types.
	No File |	No File: Metafile does not contain upgrade file information.
	Missing SOP |	Missing SOP: Metafile does not contain SOP partition while SCP is present.
	Duplicated Partition |	Duplicated Partition: Upgrade failed because either the metafile or the upgrade file has duplicated partition in it.

Parameter Name	Format	Description
	Incompatible Upgrade/Downgrade Path |	Incompatible Upgrade/Downgrade Path: Upgrade failed because upgrading/downgrading to the intended SOP version or type is not allowed by current image.
	Flash Programming Failed |	Flash Programming Failed: Failed to write the flash memory.
	Flash Programming Failed |	Flash Programming Failed: Failed to burn the flash.
	Current Image Invalidated |	Current Image Invalidated: The current image has been invalidated by a previous "fallback" command.
	No Fallback Image Available |	This reason applies to the rejection of multiple commands following a "fallback" commands.
	Generic Error >	Generic Error: Download error other than those specified above.
PrimaryImageType	STRING	The type of image stored in the primary (currently defaults to Linux)
PrimaryImageSystemVersion	STRING	The version string of the primary image system partition
PrimaryImageConfigVersion	STRING	The version string of the primary image configuration partition
SecondaryImageType	STRING	The type of image stored in the secondary (currently defaults to Linux)
secondaryImageSystemVersion	STRING	The version string of the secondary iamge system partition
secondaryImageConfigVersion	STRING	The version string of the secondary image configuration partition

Following an upgrade command, the **UpgradeStatus** can take the following values:

- Idle: the reader is not performing any upgrade related activity.
- Contacting Server: the reader is contacting the file server to download either the metafile or the upgrade image file.
- Downloading: the reader is downloading either the metafile or the upgrade image file.
- Download Failed: the download failed.
- No upgrade: the reader does not need to perform an upgrade because one of the following scenarios: (detailed reasons are given in the command response parameter as listed in Table 7-14)
    o The **upgrade-mode** as specified by the metafile is **auto** and the image specified by the metafile is no newer than the current one.
    o The **upgrade-mode** as specified by the metafile is **forced** and the image specified by the metafile is the same as the current one.
    o The upgrade image file downloaded from the server carries image with the same version as the current one.
    o The partition versions specified in the metafile or in the image downloaded are not allowed as a compatible upgrade/downgrade path.
- Bad Config: the metafile downloaded is invalid due to bad data entry syntax, missing data entries, or other possibilities.
- Bad Image: the upgrade image file is invalid due to:
    o CRC failure in the upgrade image file
    o Version numbers not matching those in the metafile that triggered the download of the image
    o The image file is corrupted for other reasons
- Erasing: the secondary image is being erased before the new upgrade image is programmed.
- Programming: the new image is being programmed.

Done: the upgrade image has been successfully committed to flash and is ready to be activated. For each abnormal status, a Reason parameter is given to indicate the reason for the status. The reason values are given in Table 7-14.

7.5.3. show logging Command

The **show logging** commands are used to display the logging parameters for the system and for displaying the log information in text form. The commands are described below.

```
Commands:
internallog - Displays the last internal log entries.
summary     - Displays the current logging levels of the internal logs.
syslog      - Displays the last syslog log entries.
exit        - Exit this submenu and return to the parent menu.
help        - Displays this help message.
.           - Exit this submenu and return to the parent menu.
?           - Displays this help message.

Sub-menus:
None
```

7.5.3.1. show logging internallog Command

Format for the **show logging internallog** command takes an integer argument to specify how many of the last internal log entries to display. The command usage is shown below:

```
Usage:  show logging internallog <eventcount>
```

An example command is shown below:

```
> show logging internallog 1
Status=0,'Success'
Event1=1156073965.245217 -- UpgradeAgent         LAPI
Logging service started at: Sun Aug 20 11:39:25 2006
 >
```

Log entries are reported from most recent to oldest. Response parameters for the **show logging <syslog|internallog>** are shown in Table 7-15.

Table 7-15 "show logging <syslog | internallog>" Response Parameters

Parameter Name	Format	Description
EventN	STRING	The string responses from the log events
EventN-1	STRING	
…	…	…
Event1	STRING	

7.5.3.2. show logging syslog Command

Format for the **show logging syslog** command takes an integer argument to specify how many log entries to display. The command usage is shown below:

```
Usage:  show logging syslog <eventcount>
```

An example command is shown below:

```
> show logging syslog 3
Status=0,'Success'
Event3=Aug 20 11:39:25 (none) ntpd[625]: bind() fd 4, family 2, port 123,
addr 10.0.10.231, in_classd=0 flags=1 fails: Address already in use
Event2=Aug 20 11:39:26 (none) thttpd[631]: socket :: - Address family not
supported by protocol
Event1=Aug 20 11:39:54 (none) dhclient: receive_packet failed on ixp0:
```

```
Network is down
```

7.5.3.3. show logging summary Command

The **show logging summary** command displays the current logging configuration for syslog and for the internal log. The command usage is shown below:

```
Usage:  show logging summary
```

Response parameters for the logging summary command are shown in
Table 7-16.

Table 7-16 "show logging summary" Response Parameters

Parameter Name	Format	Description
ApplicationLevel	<Emergency| Alert | Critical | Error | Warning | Notice | Info | Debug>	Configured the level at and above which application-level logs are sent to the log database
ConfigurationLevel		Log level for configuration
MgmtLevel		Log level for management
NetworkLevel		Log level for networking
RFIDParameters		Log level for RFID parameters
RFIDSingulation		Log level for RFID singulation
RFIDAccess		Log level for RFID access
System		Log level for system
severityLevel		The syslog security level. Only logs at or above this level will be forwarded to syslog.

A sample of the command is shown below:

```
> show logging summary
Status=0,'Success'
ApplicationLevel=critical
ConfigurationLevel=emergency
MgmtLevel=emergency
NetworkLevel=emergency
RFIDParameters=emergency
RFIDSingulation=emergency
RFIDAccess=emergency
System=emergency
severityLevel=warning
 >
```

7.5.4. show network Command

The **show network** menu contains commands to display networking parameters and statistics. All commands are single word commands and take no arguments. Commands, with their usage format, are shown below, while the response parameters are shown in Table 7-17 through Table 7-25.

```
Commands:
dhcp    - Summary of DHCP Client configuration.

dns     - Summary of DNS settings.
icmp    - ICMP statistics
iface   - Interface status
ip      - IP statistics
ntp     - Summary of NTP settings.
snmp    - Not handled yet
summary - Summary of network settings
tcp     - TCP statistics
udp     - UDP statistics
exit    - Exit this submenu and return to the parent menu.
help    - Displays this help message.
.       - Exit this submenu and return to the parent menu.
?       - Displays this help message.

Sub-menus:
None
```

The command usage for **show network dhcp** is shown below:

```
Usage:   show network dhcp
```

Table 7-17   "show network dhcp" Response Parameters

Parameter Name	Format	Description
sendHostname	on|off	Indicates the current setting for sending the hostname during DHCP negotiation.
UserClass	STRING	Displays the current setting for the user class DHCP option. If this is an empty string the user class option is not sent via DHCP. Otherwise the value indicates the string that is sent.

The command usage for **show network dns** is shown below:

```
Usage:   show network dns
```

Table 7-18   "show network dns" Response Parameters

Parameter Name	Format	Description
DomainStatic	STRING	Statically configured domain, if available
domainDynamic	STRING	DNS domain obtained from DHCP, if available
dnsServerAddress1Stat	IpAddress	Address of first static DNS server
dnsServerAddress2Stat	IpAddress	Address of second statically added DNS server
…	…	…
dnsServerAddress<N>Stat	IpAddress	Address of last statically added DNS server
dnsServerAddress1Dyn	IPAdress	Address of first dynamic DNS server obtained from DHCP server
…	…	…
dnsServerAddress<N>Dyn	IPAdress	Address of last dynamic DNS server obtained from DHCP server

The command usage for **show network icmp** is shown below:

```
Usage:   show network icmp
```

Table 7-19   "show network icmp" Response Parameters

Parameter Name	Format	Description
icmpInMsgs	Counter	See MIB-2 RFC 1213
icmpInErrors	Counter	
icmpInTimeExcds	Counter	
icmpInParmProbs	Counter	
icmpInSrcQuenchs	Counter	
icmpInRedirects	Counter	
icmpInEchos	Counter	
icmpInEchoReps	Counter	
icmpInTimestamps	Counter	
icmpInTimestampReps	Counter	
icmpInAddrMasks	Counter	
icmpInAddrMaskReps	Counter	
icmpOutMsgs	Counter	
icmpOutErrors	Counter	
icmpOutDestUnreachs	Counter	
icmpOutTimeExcds	Counter	
icmpOutParmProbs	Counter	
icmpOutSrcQuenchs	Counter	
icmpOutRedirects	Counter	
icmpOutEchos	Counter	
icmpOutEchoReps	Counter	
icmpOutTimestamps	Counter	
icmpOutTimestampReps	Counter	
icmpOutAddrMasks	Counter	
icmpOutAddrMaskReps	Counter	

A sample command is show below:

```
> show network icmp
Status=0,'Success'
icmpInMsgs=0
icmpInErrors=0
icmpInTimeExcds=0
icmpInParmProbs=0
icmpInSrcQuenchs=0
icmpInRedirects=0
icmpInEchos=0
icmpInEchoReps=0
icmpInTimestamps=0
icmpInTimestampReps=0
icmpInAddrMasks=0
icmpInAddrMaskReps=0
icmpOutMsgs=0
icmpOutErrors=0
icmpOutDestUnreachs=0
icmpOutTimeExcds=0
icmpOutParmProbs=0
icmpOutSrcQuenchs=0
icmpOutRedirects=0
icmpOutEchos=0
icmpOutEchoReps=0
icmpOutTimestamps=0
icmpOutTimestampReps=0
icmpOutAddrMasks=0
icmpOutAddrMaskReps=0
```

The command usage for **show network iface** is shown below:

```
Usage:  show network iface
```

Table 7-20   "show network iface" Response Parameters

Parameter Name	format	Description
IfIface	DisplayString	Interface Name
IfMTU	integer	Maximum Transfer Unit Size
IfMet	integer	Interface Metric
ifRx-OK	integer	Successful Receive Frames
ifRX-ERR	integer	Errored Receive Frames
ifRF-DRP	integer	Dropped Receive Frames
ifRF-OVR	integer	Receiver Overruns
ifTX-OK	integer	Successful Transmit Frames
ifTx-ERR	integer	Errored Transmit Frames
ifTx-DRP	integer	Dropped Transmit Frames
ifTx-OVR	integer	Transmitter Overruns
IfFlg	DisplayString	B -- broadcast address has been set. L --This interface is a loopback device. M --All packets are received (promiscuous mode). O --ARP is turned off for this interface. P --This is a point-to-point connection. R --Interface is running. U --Interface is up.

A sample command is shown below:

```
show network > iface
Status=0,'Success'
ifIface=ixp0
ifMTU=1500
ifMet=0
ifRX-OK=31921
ifRX-ERR=0
ifRX-DRP=0
ifRX-OVR=0
ifTX-OK=24338
ifTX-ERR=0
ifTX-DRP=0
ifTX-OVR=0
ifFlg=BMRU
```

The command usage for **show network ip** is shown below:

```
Usage:  show network ip
```

Table 7-21   "show network ip" Response Parameters

Parameter Name	Format	Description
ipForwarding	INTEGER	See MIB-2 RFC 1213
ipDefaultTTL	INTEGER	
ipInReceives	Counter	
IpInHdrErrors	Counter	
ipInAddrErrors	Counter	
ipForwDatagrams	Counter	
ipInUnknownProtos	Counter	
ipInDiscards	Counter	
ipInDelivers	Counter	
ipOutRequests	Counter	
ipOutDiscards	Counter	
ipOutNoRoutes	Counter	
ipReasmTimeout	INTEGER	
ipReasmReqds	Counter	
IpReasmOKs	Counter	
IpReasmFails	Counter	
ipFragOKs	Counter	
ipFragFails	Counter	
ipFragCreates	Counter	
IpRoutingDiscards	Counter	

A sample command is shown below:

```
> show network ip
Status=0,'Success'
ipForwarding=2
ipDefaultTTL=64
ipInReceives=22028
ipInHdrErrors=0
ipInAddrErrors=0
ipForwDatagrams=0
ipInUnknownProtos=0
ipInDiscards=0
```

```
ipInDelivers=22001
ipOutRequests=23126
ipOutDiscards=0
ipOutNoRoutes=0
ipReasmTimeout=0
ipReasmReqds=0
ipReasmOKs=0
ipReasmFails=0
ipFragOKs=0
ipFragFails=0
ipFragCreates=0
ipRoutingDiscards=0
```

The command usage for **show network ntp** is shown below:

```
Usage:   show network ntp
```

Table 7-22   "show network ntp" Response Parameters

Parameter Name	Format	Description
NtpServerAddress1Stat	STRING	Address of the first statically added NTP server
NtpServerAddress2Stat	STRING	Address of the second statically added NTP server
…	…	…
NtpServerAddress<N>Stat	STRING	Address of the last NTP server
NtpServerAddress1Dyn	STRING	Address of the first NTP server obtained from DHCP server
NtpServerAddress2Stat	STRING	Address of the second dynamic NTP server obtained from DHCP server
…	…	…
NtpServerAddress<N>Dyn	STRING	Address of the last NTP server obtained from DHCP server

A sample command is shown below:

```
> show network ntp
Status=0,'success'
NtpServerAddress1Stat=140.142.16.34
```

The command usage for **show network summary** is shown below:

```
Usage:   show network summary
```

Table 7-23 "show network summary" Response Parameters

Parameter Name	Format	Description
ipAddressMode	STRING	If configuration is currently dynamic, the dynamic values returned by DHCP are returned
ipAddress	ipAddress	
IpMask	ipAddress	
gatewayAddress	ipAddress	
broadcastAddress	ipAddress	
hostname	STRING	

A sample command is shown below:

```
> show network summary
Status=0,'success'
ipAddressMode=dynamic
ipAddress=192.168.8.98
ipMask=255.255.252.0
gatewayAddress=192.168.8.1
broadcastAddress=192.168.11.255
hostname=rdr-100-64
```

The command usage for **show network tcp** is shown below:

```
Usage:  show network tcp
```

Table 7-24 "show network tcp" Response Parameters

Parameter Name	Format	Description
tcpRtoAlgorithm	INTEGER	See MIB-2 RFC 1213
tcpRtoMin	INTEGER	
tcpRtoMax	INTEGER	
tcpMaxConn	INTEGER	
tcpActiveOpens	Counter	
tcpPassiveOpens	Counter	
tcpAttemptFails	Counter	
tcpEstabResets	Counter	
tcpCurrEstab	Gauge	
tcpInSegs	Counter	
tcpOutSegs	Counter	
tcpRetransSegs	Counter	
tcpInErrs	Counter	
tcpOutRsts	Counter	

A sample command is shown below:

```
> show network tcp
Status=0,'Success'
tcpRtoAlgorithm=0
tcpRtoMin=0
tcpRtoMax=0
tcpMaxConn=0
tcpActiveOpens=4
tcpPassiveOpens=33
tcpAttemptFails=0
tcpEstabResets=0
tcpCurrEstab=2
```

```
tcpInSegs=14269
tcpOutSegs=22171
tcpRetransSegs=0
tcpInErrs=0
tcpOutRsts=2
```

The command usage for **show network upd** is shown below:

```
Usage:   show network udp
```

Table 7-25   "show network udp" Response Parameters

Parameter Name	Format	Description
udpInDatagrams	Counter	See MIB-2 RFC 1213
udpNoPorts	Counter	
udpInErrors	Counter	
udpOutDatagrams	Counter	

A sample command is shown below:

```
> show network udp
Status=0,'Success'
udpInDatagrams=917
udpNoPorts=0
udpInErrors=0
udpOutDatagrams=976
```

7.5.5. show system Command

The **show system** menu displays information on the system state of the reader. Command usage for each subcommand is show below, and Table 7-26 through Table 7-27 summarize the respective response parameters. Examples for each follow.

```
Commands:
cpu      - Platform memory usage and available application space
statistics.
platform - Displays generic platform statistics.
summary  - Displays system information
exit     - Exit this submenu and return to the parent menu.
help     - Displays this help message.
.        - Exit this submenu and return to the parent menu.
?        - Displays this help message.

Sub-menus:
None
```

The command usage for **show system cpu** is shown below:

```
Usage:   show system cpu
```

Table 7-26 "show system cpu" Response Parameters

Parameter Name	Format	Description
TotalMemory	Unsigned32	Total available RAM in bytes
FreeMemory	Unsigned32	Total free RAM in bytes
CpuUtilization	Unsigned32	CPU utilization in percent
TotalConfigurationStorageSpace	Unsigned32	Total Configuration partition space in bytes
FreeConfigurationStorageSpace	Unsigned32	Free Configuration partition space in bytes
TotalApplicationStorageSpace	Unsigned32	Total Application partition space in bytes
FreeApplicationStorageSpace	Unsigned32	Free Application partition space in bytes

```
> Show system cpu
Status=0,'success'
TotalMemory=64606208
FreeMemory=45469696
CpuUtilization=3
TotalConfigurationStorageSpace=2097152
FreeConfigurationStorageSpace=1335296
TotalApplicationStorageSpace=2097152
FreeApplicationStorageSpace=1437696
```

The command usage for **show system platform** is shown below:

```
Usage:  show system platform
```

Table 7-27 "show system platform" Response Parameters

Parameter Name	Format	Description
hardwareVersion	Display String	Returns the current hardware version information
serialNumber	Display String	Returns the hardware serial number
bIOSVersion	Display String	Returns the version information for the reader BIOS
MacAddress	Display String	MAC Address of unit's Ethernet port
UptimeSeconds	<Time ticks>	Time since last reboot in seconds

```
> show system platform
Status=0,'success'
hardwareVersion=010-000.027255
serialNumber=00-06-02-00022
biosVersion=1.1.0 RC 2
macAddress=00:16:25:00:01:18
uptimeSeconds=5836
```

The command usage for **show system summary** is shown below:

```
Usage:  show system summary
```

Table 7-28 "show system summary" Response Parameters

Parameter Name	Format	Description
SysDesc	DisplayString	A system description; defaults to make and model number of reader
SysContact	DisplayString	The system contact information – defaults to unknown
SysName	DisplayString	A system name – defaults to speedway-xx-xx-xx where xx-xx-xx are the last three octets of the MAC address.
SysLocation	DisplayString	A system location – defaults to unknown
SysTime	DisplayString	A time in UTC

```
> show system summary
Status=0,'Success'
sysDesc='Impinj Speedway'
sysContact='unknown'
sysName='speedway-00-00-08'
sysLocation='unknown'
sysTime='Tue Apr 25 16:04:59 UTC 2006'
```

7.6. Transfer Command

If a **help transfer** command is entered at the command line interface, the system will respond as follows to indicate the need to enter subcommands:

```
> help transfer
transfer - Submenu of transfer commands.
Usage:  transfer [<subcommand> ...]
```

The **transfer** menu contains commands for transferring files from the reader. Syslog and internal log files stored on the reader can be offloaded to remote servers. The transfer commands have the following format:

```
Commands:
from-reader - Transfer a file from the reader to a remote URI.
status      - Display status of any currently active transfer.
exit        - Exit this submenu and return to the parent menu.
help        - Displays this help message.
.           - Exit this submenu and return to the parent menu.
?           - Displays this help message.

Sub-menus:
None
```

7.6.1. transfer from-reader Command

The **transfer from-reader** command uploads files from the reader. The command requires two arguments, the first of which specifies the file to upload; the second specifies the URI destination for the file. The file upload options are **internallog** or **syslog**. The **internallog** and **syslog** options upload the internal log and syslog respectively to a file specified by the URI that must end in .txt.gz. The command usage is shown below:

```
Usage:  from-reader <internallog|syslog> <URI>
```

The following URI formats are accepted by this command:

```
tftp://<servername>/<directory>/<file>.txt.gz
ftp://<user>:<password>@<servername>/<directory>/<file>.txt.gz
```

A sample command is shown below:

```
> transfer from-reader syslog tftp://10.0.10.37/syslog.txt.gz
Status=0,'Success'
>
```

7.6.2. transfer status Command

The **transfer status** command displays the current status of the transfer sub-system. The command usage is shown below. This command takes no arguments.

```
Usage:  transfer status
```

Table 7-29 "transfer status" Command Response

Parameter Name	Format	Description
TransferStatus	<Unknown | Contacting Server | Transferring | Transfer Failed | Done>	The status of the transfer. Unknown means there is no outstanding transfer command.
Reason	< Unknown Host | Access Denied | File Not Found | Timeout | Invalid URI Format | Invalid URI Format (username:password@host)>	Reason for failure of transfer. Note that when using TFTP to upload, the remote file may have to be already on the server with the right permission, otherwise transfer fails with reason "File Not Found" or "Access Denied". If the remote URI is invalid, transfer fails with reason "Invalid URI Format" and if FTP is used, the correct form is given in the Reason string.

An example of a failed transfer has the following status response:

```
> transfer status
Status=0,'Success'
TransferStatus=Transfer Failed
Reason=Unknown Host
>
```

8. Troubleshooting

Refer to Table 8-1 for resolution of common problems. For additional technical support, please contact Impinj. For units not purchased directly from Impinj, please contact your VAR directly.

Table 8-1   Troubleshooting

Problem	Solution
The reader's default page does not load.	Most likely the reader operating system is still booting or TCP/IP connectivity has been lost. Retry or "ping" the reader to verify connectivity. If more than 50 seconds have elapsed since power was applied, disconnect and reconnect power, then re-attempt to ping the unit after 50 seconds.
Java applet does not load after selecting "RFID" from default page.	Verify that the PC's web browser has Java Runtime Environment (JRE) of version 1.4.2 or later. The latest version of JRE may be installed from: http://java.com/en/download/manual.jsp
"Initializing" or "Calibrating" dialog boxes do not disappear.	The reader has likely locked up. Power cycle the reader.
Tags/sec rate varies when configuration settings are changed.	This is normal. Currently, the Maximum Throughput mode should have >200 tags/sec, while Dense-Reader or Initialization modes are ~100 tags/sec. Some transmit frequencies will be better than others (no interference or less noise). Best rates will be achieved with 10 to 30 tags within range.
None of the recommend actions fixes the problem.	Power-cycle the reader

9. References

Reference	Description
MIB-2 RFC 1213	Management Information Base for Network Management of TCP/IP-based internets:MIB-II. K. McCloghrie, M. Rose. March 1991.
RFC 3986	Uniform Resource Identifier (URI): Generic Syntax. T. Berners-Lee, R. Fielding, L. Masinter. January 2005.

Appendix A Impinj Factory Default Configuration

Detailed below are the factory default configuration settings for the Speedway reader. Except for the username and password, all entries are shown when the "show all config" command is issued on a Speedway reader in its factory default configuration.

Username: root
Password: impinj

Networking Category
Static domain: None
IpAddressMode: dynamic   # (using DHCP to obtain IP address)
hostname: speedway-xx_h-xx_h-xx_h, # where xx_h-xx_h-xx_h are the last three bytes of the reader's MAC address (in hex)
SendHostname: on
Userclass: None
Static DNS server: None
Static NTP server: None
System Info category:
system Description: 'Impinj Speedway'
system Contact: 'http://www.supplier.com/techsupport'
system name: 'speedway-xx-xx-xx'   # same as default hostname
system Location: 'unknown'

Upgrade Agent Category
MetafileUri: Empty
RetrieveMode: push

Logging Category
ApplicationLevel: emergency
ConfigurationLevel: emergency
MgmtLevel: emergency
NetworkLevel: emergency
RFIDParameters Level : emergency
RFIDSingulation Level: emergency
RFIDAccess Level: emergency
System Level: emergency
syslog severityLevel: error
static syslog server: none

Appendix B Command Line Editing in Rshell

Key	Sequence	Action
Printable char		Insert character at cursor position then move cursor right one.
KEY_LEFT	Control-B, \033[D	Move cursor left one. Sticks at begin-of-line.
KEY_RIGHT	Control-F, \033[C	Move cursor right one. Sticks at end-of-line.
KEY_HOME	Control-A, \033[1~	Move cursor to begin-of-line.
KEY_END	Control-E, \033[4~	Move cursor to end-of-line
KEY_DELETE	Control-D, \033[3~	Delete character at cursor position. Leave cursor at same position.
KEY_BACKSPACE	Control-H	Move cursor left one then same as KEY_DELETE. Does nothing at begin-of-line.
KEY_ERASELINE	Control-U	Erase entire line, place cursor at begin-of-line
KEY_ENTER	Control-J, Control-M	Move cursor to end-of-line. Return the line to the caller for processing.
KEY_UP	Control-P, \033[A	Move up (earlier) the history list. Erases current line, copies in and displays history entry, places cursor at end-of-line.
KEY_DOWN	Control-N, \033[B	Move down (later) the history list. Erases current line, copies in and displays history entry, places cursor at end-of-line.
anything else		Ignored

9.1.1.1. Notices

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